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NATIONAL
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MARTIN MARIETTA

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**Environmental and Occupational
Safety Division Annual Progress
Report for 1983**

ChemRisk Document No. 1009

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
THE UNITED STATES
DEPARTMENT OF ENERGY

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**ENVIRONMENTAL AND OCCUPATIONAL SAFETY DIVISION
ANNUAL PROGRESS REPORT FOR 1983**

Date of Issue: November 1984

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
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CONTENTS

1. INTRODUCTION	1
2. TECHNICAL HIGHLIGHTS	3
3. HEALTH PHYSICS DEPARTMENT	7
3.1 RADIATION MONITORING	7
3.1.1 Personnel Monitoring	7
3.1.2 Health Physics Instrumentation	11
3.2 DEVELOPMENTS	13
3.2.1 Biometric Estimation of Chest Wall Thickness	13
3.2.2 Validation of Calibration Factors for Long-Term ²⁴¹ Am Deposition Measurements in Humans	13
3.2.3 Quality Assurance for the ORNL Pocket Meter Program	13
4. ENVIRONMENTAL MANAGEMENT PROGRAM	15
4.1 DEPARTMENT OF ENVIRONMENTAL MANAGEMENT	15
4.2 ENVIRONMENTAL MANAGEMENT FUNCTIONS	15
4.2.1 Compliance Evaluation Inspection Response	17
4.2.2 Resource Management Plan	18
4.3 ATMOSPHERIC MONITORING	18
4.3.1 Air Concentrations	18
4.3.2 Fallout (Gummed Paper Technique)	19
4.3.3 Rainout (Gross Analysis of Rainwater)	19
4.3.4 Atmospheric Radioiodine (Charcoal Cartridge Technique)	19
4.3.5 Nonradioactive Air Particulates	19
4.3.6 Milk Analysis	20
4.3.7 ORNL Stack Releases	20
4.4 WATER MONITORING	20
4.4.1 White Oak Lake Waters	20
4.4.2 Potable Water	20
4.4.3 Clinch River Fish	22
4.5 RADIATION BACKGROUND MEASUREMENTS	22
4.6 SOIL AND GRASS SAMPLES	24
4.7 DEER SAMPLES	24
4.8 CALCULATION OF POTENTIAL RADIATION DOSE TO THE PUBLIC	24
4.8.1 Maximum Potential Exposure	28
4.8.2 Dose to the Population	29

4.9 MAJOR ACTIVITIES OF THE DEPARTMENT OF ENVIRONMENTAL MANAGEMENT	29
4.9.1 Environmental Data Assessment Group	29
4.9.2 Environmental Engineering Group	36
4.9.3 Environmental Surveillance Group	39
4.9.4 Hazardous Materials Control Group	42
5. SAFETY DEPARTMENT	45
5.1 INDUSTRIAL SAFETY	45
5.1.1 Industrial Safety Activities	45
5.1.2 Construction Safety	46
5.1.3 Off-the-Job Safety	46
5.1.4 Safety Performance	46
5.1.5 Education and Training	47
5.2 OFFICE OF OPERATIONAL SAFETY	48
5.2.1 Laboratory Director's Review Committees	48
5.2.2 DSO-RCO Activities	48
5.2.3 ORNL Safety Analysis and Review Program	50
5.2.4 Facility Decontamination and Decommissioning (D&D)	50
5.2.5 Unusual Occurrence Reporting (UOR) System	51
5.2.6 Staff Consultation, Review, and Other Activities	51
5.2.7 Summary	52
6. RADIATION AND SAFETY SURVEYS DEPARTMENT	53
6.1 FACILITIES' OPERATIONS MONITORING	53
6.2 OFF-SITE AND SPECIAL SURVEILLANCE ACTIVITIES	60
6.2.1 Inspection of Threshold Detector Units	60
6.2.2 Preliminary Radiological Characterization Studies of Surplus Facilities	62
6.2.3 Work Environment Surveys for Pregnant Employees	62
6.2.4 Response to Off-Site Emergencies	63
6.2.5 Oak Ridge Associated Universities (ORAU) Off-Site Assessment Assistance	63
6.2.6 Servicing of Threshold Detector Units	63
6.2.7 Consultations	63
6.2.8 Participation in Emergency Drills	63
6.2.9 DOSAR Facility, Buildings 7709 and 7710	64
7. TECHNICAL ACTIVITIES	65
7.1 PRESENTATIONS AND LECTURES	65
7.2 PUBLICATIONS	69
7.3 EOS LUNCHEON SEMINARS	71
7.4 PROFESSIONAL ACTIVITIES AND ASSOCIATIONS	71

1. INTRODUCTION

On November 1, 1983, the Division's name was changed from Industrial Safety and Applied Health Physics to Environmental and Occupational Safety. The change was made to indicate the broad responsibilities of the Division in the environmental and occupational areas and to reflect the Laboratory's commitment to environmental and occupational safety in all aspects of its operations.

The change in name was only one of many that occurred in 1983. Organizational changes were made in the Department of Environmental Management and the Health Physics Department and a fourth department, Radiation and Safety Surveys, was created. These changes were made to place the Division in a better position to address the challenges of the future. In the Department of Environmental Management, environmental engineering activities at ORNL and Y-12 were consolidated to focus and strengthen our engineering resource. Additional staff were acquired so that the Division would be better able to respond to engineering requirements associated with a variety of new environmental projects. In the Health Physics Department, activities in the area of radiation monitoring and dosimetry were consolidated into four major groups, which served to strengthen our existing capabilities and provide an organizational framework for more direct interaction and collaboration with relevant ORNL research divisions. The creation of the Radiation and Safety Surveys Department reflected the increasing importance of the survey organization in the area of worker protection extending beyond the area of health physics into general safety concerns.

The past year was a time of tremendous change within the Division. Along with the organizational changes outlined above, there were many changes in staff resulting from retirements and departures from the Laboratory; a large number of new staff members joined the Division to fill these positions. We are all beneficiaries of the contributions of those individuals who are now completing their professional careers and going on to retirement. The Division and the Laboratory owe them a very large debt of gratitude for their many years of dedicated service. It is because of their many contributions that we will be able to meet the demands of the days ahead.

2. TECHNICAL HIGHLIGHTS

During 1983, the Environmental and Occupational Safety Division continued its long record of working to safeguard the well-being of those individuals employed at the Laboratory and of the environment surrounding the Laboratory. This responsibility includes activities in the areas of environmental management, radiation protection, and occupational safety. Technical accomplishments during 1983 included maintenance of the Laboratory's excellent health and safety record as well as the development of some important new tools to aid in our mission of protecting the Laboratory staff and the environment.

The Health Physics Department is responsible for the operation of the Laboratory's personnel monitoring program for both internal and external radiation exposures and the acquisition, calibration, and service of the Laboratory's radiation monitoring instrumentation. The personnel monitoring activities of the department have made it possible to draw the following conclusions regarding potential radiation exposures to individuals considered radiation workers:

- The maximum whole-body dose received by an employee was approximately 20 mSv (2.0 rem). This value represents 40% of the applicable radiation standard of 50 mSv (5.0 rem).
- At the end of 1983, the greatest cumulative whole-body dose received by any employee was approximately 0.98 Sv (98.0 rem). This dose was accrued over a period of 34 years and represents an annual dose of 28 mSv/yr (2.8 rem/yr).
- The greatest cumulative dose to the skin of the whole body received by an employee during 1983 was approximately 63 mSv (6.3 rem), 42% of the applicable radiation standard of 150 mSv (15 rem).
- During 1983 no cases of internal exposure occurred for which the amount of radioactive material within the body averaged as much as one-half of the maximum permissible organ burden for the year.

Along with activities directed toward characterizing the extent of radiation dose to Laboratory employees, Health Physics Department staff members developed new techniques to enhance the effectiveness of our radiation protection program. The techniques include:

- Derivation of algorithms used for estimation of male and female chest wall thickness to reduce the error associated with estimation of internal actinide deposition.
- Development of a quality assurance program for indirect-reading pocket dosimeters to ensure the validity of measurements obtained through this important dosimetry system.

The Department of Environmental Management has responsibility for the measurement, field monitoring, and evaluation of effluents released as a result of Laboratory operations and the control of hazardous materials used within ORNL. As a result of monitoring activities carried out by Environmental Management staff, conclusions can be drawn about the potential radiation exposures attributed to releases from the Laboratory:

- Atmospheric iodine sampled at perimeter monitoring stations averaged $0.44\text{E}-4 \text{ Bq/m}^3$ ($0.12\text{E}-14 \text{ } \mu\text{Ci/cm}^3$) during 1983. This value represents $<0.002\%$ of the concentration guide of 3.7 Bq/m^3

($1\text{E}-10 \mu\text{Ci}/\text{cm}^3$) applicable to inhalation of ^{131}I released to uncontrolled areas. The maximum concentration observed for one week was $0.55\text{E}-4 \text{ Bq}/\text{m}^3$ ($0.15\text{E}-13 \mu\text{Ci}/\text{cm}^3$).

- The concentrations of ^{131}I in milk collected near the Laboratory and from all remotely located stations were less than the minimum detectable levels of ^{131}I in milk [$17.0 \text{ mBq}/\text{L}$ ($0.45 \text{ pCi}/\text{L}$)]. The concentrations of ^{90}Sr in milk from both the local and remote environs were well within Federal Radiation Council (FRC) Range 1.
- The average concentration of ^{90}Sr in potable water was $0.19\text{E}-01 \text{ Bq}/\text{L}$ ($0.51\text{E}-09 \mu\text{Ci}/\text{mL}$). This value represents 0.2% of the drinking water concentration guide for members of the general population.
- A whole-body dose of $2.5 \text{ mSv}/\text{yr}$ ($250 \text{ mrem}/\text{yr}$) was calculated for the maximum potential exposure assuming an individual remained at this site boundary location 24 h/d for the entire year. The calculated hypothetical dose is 50% of the allowable standard.

In addition to these monitoring activities, a number of technical accomplishments were made in 1983 by the staff of the Department of Environmental Management:

- Publication of a 17-volume Resource Management Plan to address issues involving use of the natural resources found on the Oak Ridge Reservation. This project involved individuals from a number of ORNL divisions, individuals at each of the three plants on the reservation, and UCC-ND staff.
- Publication of a 2-volume response to the August 23, 1983, Compliance Evaluation Inspection conducted by the Tennessee Department of Health and Environment and the Environmental Protection Agency responding to the various environmental concerns identified during the inspection.

The Safety Department is the Laboratory organization responsible for the various aspects of operational and industrial safety. The efforts of all the Laboratory staff involved in implementation of the Safety Program resulted in a number of major accomplishments, including:

- The National Safety Council Award of Honor for the ninth consecutive year.
- The Department of Energy Award of Excellence for maintaining the incidence rate of lost workdays and restricted work cases below 1.1 for five years.
- Accumulation of 157 days (3,339,681 exposure-hours) through December 31, 1983, without a single lost workday case.

During 1983, excellent progress was made on the preparation of safety documentation for nuclear facilities at the Laboratory. These documents, the Safety Analysis Reports (SARs) and the Operational Safety Requirements (OSRs), constitute important tools in assuring that the Laboratory's reactors and nonreactor nuclear facilities continue to operate in a safe manner in accordance with Laboratory and DOE requirements. Progress in this documentation process included:

- Formal approval by DOE/ORO of SARs and OSRs for seven existing facilities and five new facilities.
- Completion of draft SARs and OSRs for nine other facilities and one new project, the Consolidated Edison Uranium Solidification Project.

The Radiation and Safety Surveys Department is responsible for surveillance of activities at the various research and support facilities at the Laboratory. The day-to-day contact requires staff involvement in all levels of operation. During the past year staff from the Department participated in a number of critically important activities with the purpose of maintaining radiation exposures to as-low-as-reasonably achievable. These activities included:

- Installation of spool sections in the inlet and exit lines of the Oak Ridge Research Reactor to eliminate leakage of coolant water from the lines. In spite of the complexity of this work and the high radiation levels, exposure to Laboratory staff remained at acceptable levels.
- Replacement of the High Flux Isotope Reactor beryllium reflector ring, requiring a three-month shutdown of the reactor and around-the-clock coverage by Department staff. Exposure levels to all personnel were kept well below applicable limits.
- Recovery of the Hydrofracture Facility well and subsequent injection of radioactive waste stored at the Gunita Tank Farm to permit permanent disposal of 18.8 PBq (509,580 Ci) of activity. Involvement in these projects kept radiation exposures to Laboratory staff to minimum levels.

Department staff were also involved in a number of activities associated with the Laboratory's decommissioning program and the current initiatives in emergency response:

- Decontamination and decommissioning of a cell in Building 3517, requiring removal and disposal of piping and material in high radiation backgrounds. Two months were needed to carry out the work and in no case did any single exposure exceed 10% of the annual exposure limit.
- Cleanup and disposal of excess radioactive material stored in the High-Level Radiochemical Laboratory vaults. All exposures associated with the cleanup were within permissible limits.
- Participation in two off-site emergency response activities and three emergency drills at the request of the Oak Ridge Operations Office of the Department of Energy.

3. HEALTH PHYSICS DEPARTMENT

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3.1 RADIATION MONITORING

3.1.1 Personnel Monitoring

All persons who enter Laboratory areas where they may be exposed to radiation or radioactive materials are monitored for probable kinds of exposure. External radiation dosimetry is accomplished mainly by badge meters and pocket ion chambers, although hand exposure meters are used in some cases. Internal deposition of radionuclides is estimated from bioassays and whole-body counting.

Dose Analysis Summary

External exposure. In 1983, no employee received a whole-body radiation dose that exceeded the standards for radiation protection given in DOE Order 5480.1.¹ The maximum whole-body dose sustained by an employee was approximately 20 mSv (2 rem) [40% of the applicable standard of 50 mSv (5 rem)]. The range of doses to persons using ORNL badge meters is shown in Table 3.1.

At the end of 1983, no employee had a cumulative whole-body dose greater than the applicable standard based on the age proration formula, $5(N - 18)$ (Table 3.2). No employee had an average annual dose exceeding 50 mSv/year (5 rem/year) of employment (Table 3.3). The greatest cumulative whole-body dose received by an employee is approximately 0.98 Sv (98 rem). This dose was accrued over an employment period of about 34 years and represents an average of about 28 mSv/year (2.8 rem/year). The average of the ten greatest whole-body doses to ORNL employees for the years 1979 through 1983 is shown in Table 3.4.

The greatest cumulative dose to the skin of the whole body received by an employee during 1983 was approximately 63 mSv (6.3 rem) [42% of the applicable standard of 150 mSv (15 rem)]. The maximum cumulative hand dose received during the year was approximately 70 mSv (7 rem) [9% of the applicable standard of 750 mSv (75 rem)].

1. DOE Order 5480.1, Chapter XI.

**Table 3.1. 1983 dose data summary for monitored personnel
involving exposure to whole-body radiation**

Group	Dose range [mSv (rem)]							Total
	0-1 (0-0.1)	1-10 (0.1-1)	10-20 (1-2)	20-30 (2-3)	30-40 (3-4)	40-50 (4-5)	50 up (5 up)	
ORNL employees	60	200	35	4	0	0	0	299
ORNL-monitored nonemployees	509	29	0	0	0	0	0	538
Total	569	229	35	4	0	0	0	837

Table 3.2. 1983 average dose per year since age 18

Group	Dose range [mSv (rem)]						Total
	0-10 (0-1)	10-20 (1-2)	20-30 (2-3)	30-40 (3-4)	40-50 (4-5)	50 up (5 up)	
ORNL employees	270	25	4	0	0	0	299

Table 3.3. 1983 average dose per year of employment at ORNL

Group	Dose range [mSv (rem)]						Total
	0-10 (0-1)	10-20 (1-2)	20-30 (2-3)	30-40 (3-4)	40-50 (4-5)	50 up (5 up)	
ORNL employees	232	63	4	0	0	0	299

**Table 3.4. Average highest whole-body doses
and highest individual dose by year**

Year	Ten highest doses (average)		Highest dose	
	mSv	rem	mSv	rem
1979	22.4	2.24	28.0	2.80
1980	24.6	2.46	31.4	3.14
1981	22.0	2.20	38.3	3.83
1982	16.1	1.61	21.1	2.11
1983	20.2	2.02	26.5	2.65

Internal exposure. During the year, no cases of internal exposure occurred for which the amount of radioactive material within any reference organ averaged as much as one-half of the maximum permissible organ burden for the year.

External Dose Techniques

Badge dosimeters. Standard thermoluminescent dosimeters (TLDs) are issued to all employees and to photobadged nonemployees who work in radiation zones. Standard TLD meters have two TLD chips, one shielded and one unshielded. Supplementary meters with various complements of TLDs and films are issued to those who may be exposed to radiations other than gamma and energetic beta. Standard UCC-ND TLD meters and supplementary meters of radiation workers are exchanged and processed quarterly (more frequently if required for exposure control). All other meters are exchanged and processed annually. Quarterly reports document skin and whole-body dose data for the previous calendar quarter and totals for the current year. An annual report provides a summary of the quarterly reports.

Pocket meters. Pocket meters (indirect-reading ionization chambers) are available at all principal points of entry to the Laboratory. A pair of pocket meters is worn by each person who works in an area where the potential exists for a dose of 0.2 mGy (20 mrad) or more during the work shift. Returned meters are processed daily by health physics technicians; over 140,000 pocket ionization chambers were used and processed during 1983. Supervision receives a daily report that includes the names, division affiliations, and readings for pocket meter wearers that were 0.2 mGy (20 mrad) or greater for the previous 24 h. A report of all pocket meter data for the previous week and summary data for the calendar quarter is published and distributed weekly. Pocket meter readings are used for estimating integrated exposure as a basis for possible initiation of interim TLD meter processing within a TLD meter assignment period.

Hand exposure meters. TLD-loaded finger rings are issued to persons during operations in which the hand dose is likely to exceed 10 mSv (1 rem) within one week. They are issued and collected by Radiation and Safety Surveys (R&SS) Department personnel, who determine the need for this type of monitoring and arrange a processing schedule. A summary of personnel meter services is presented in Table 3.5.

Internal Dose Techniques

Radioassay. Urine and fecal samples are analyzed to estimate radionuclide intake for monitored individuals. Sampling frequency and radiochemical analysis type are based on specific radioisotope and intake potential. Radioassay data require interpretation to estimate the dose to the exposed individual. Computer programs implementing accepted metabolic and dosimetric models facilitate analysis of excretion data. Dose estimates are made for all individuals who may have exceeded a time-integrated radionuclide concentration equivalent to one-fourth of a maximum permissible organ burden averaged over a calendar year. The radioassay laboratory also analyzes a limited number of milk and water samples for environmental monitoring purposes (see Table 3.6). The radioactivity content of samples prepared in the radioassay laboratory is determined in a counting facility that is also used to determine the radioactivity content of air filter, water, and various other samples submitted by the EOS departments (see Table 3.7).

Table 3.5. Personnel meter devices

	1981	1982	1983
Pocket meter usage			
Number of pairs used			
ORNL	69,722	64,418	66,126
CPAF ^a	6,384	6,210	6,072
Total	76,106	70,628	72,198
Average number of users per quarter			
ORNL	673	623	642
CPAF ^a	133	135	132
Total	806	758	774
Meters processed for monitoring data			
Beta-gamma badge meter	3,548	3,590	2,218
Neutron badge meter	1,159	1,177	1,399
Hand meter	285	296	487

^aCost plus award-fee contractor (Rust Engineering).

Table 3.6. Radioassay laboratory analyses, 1983

Radionuclide	Urine	Feces	Milk	Water	Controls
Plutonium, α	353	1		53	52
Transplutonium, α	315	1		53	52
Uranium, α	168				54
Strontium, β	162		256		104
Tritium	285			153	104
¹³¹ I			257		52
Other	33	1			20
Total	1316	3	513	259	436

Table 3.7. Counting facility analyses, 1983

Type of sample	Number of samples		Total
	α	β	
Facility monitoring			
Smears	16,765	16,633	33,398
Air filters	13,411	12,973	26,384
Environ monitoring			
Air filters	3,032	3,032	6,064
Fallout		2,962	2,962
Rainwater		797	797
Surface water		330	330
Total	33,208	36,727	69,935

Whole-body counter. The whole-body counter (or in vivo gamma spectrometer) is used for estimating internally deposited quantities of most photon or X-ray-emitting radionuclides. About 650 whole-body, chest, wound, thyroid, and liver counts were performed at the Whole-Body Counter Facility during the year. Preliminary results are reported soon after counting is completed; summary reports are published and distributed quarterly and annually. Most of the subjects counted had ^{137}Cs in the range of 37–555 Bq (1–15 nCi), thought to be from fallout from atmospheric weapons testing. Small quantities of various fission or activation products were identified in a few individuals during the year, but no one was found to have an average annual internal deposition greater than 10% of the maximum permissible organ burden of any isotope.

3.1.2 Health Physics Instrumentation

Nonelectronic radiation monitoring devices used in the Laboratory health physics program are selected, tested, calibrated, and maintained by EOS Division, which shares with the Instrumentation and Controls (I&C) Division the responsibility of selecting electronic radiation monitoring instruments. The EOS Division is responsible for determining the need for new instrument types and modifications to existing types, for specifying the health physics design requirements, and for approving the design; it is also responsible for calibrating all instruments used in the health physics program and is allocated funds to maintain them. Maintenance is performed or cross-ordered by the I&C Division.

Instrument Inventory

The electronic instruments used in the health physics program are divided into two classes for convenience of servicing and calibrating: battery-powered portable instruments and ac-powered stationary instruments. The portable instruments are assigned and issued to the R&SS complexes. The stationary instruments are the property of the ORNL division responsible for monitoring the areas in which the instruments are located. Table 3.8 lists the portable instruments and Table 3.9 lists the stationary instruments in use at the end of 1983. Service summaries and calibration records enable the Monitoring Instrumentation Group to maintain a current inventory on most health physics instrument requirements. Allocation of stationary health physics monitoring instruments by division is shown in Table 3.10.

Calibration Facility

The EOS Division maintains a facility, equipped with calibration sources, remote control devices, and shop space for the use of I&C maintenance personnel, for calibration and maintenance of portable radiation instruments and personnel metering devices. Radiation sources used for calibration have either been standardized by the National Bureau of Standards (NBS) or evaluated by comparison with sources standardized by the NBS. The EOS personnel assign, calibrate, arrange for maintenance, provide for delivery, and maintain inventory and servicing data on all portable health physics instruments. The recommended maintenance and calibration frequency is every two (no more than three) months for instruments that measure exposure, absorbed dose, or dose-equivalent rates (cutie pie, Juno, and fast-neutron survey meter) and every three (no more than four) months for count-rate instruments (gas flow, scintillation, Geiger-Müller survey meter, thermal neutron, and air proportional). Table 3.11 shows the number of calibrations of portable instruments and personnel monitoring devices performed during 1983.

Table 3.8. Portable instrument inventory

Instrument type	Number		Total (Jan. 1, 1984)
	Installed	Retired	
GM survey meter	1	1	318
Cutie pie	15	15	316
Alpha survey meter	2	0	261
Neutron survey meter	0	7	94
Miscellaneous	1	4	3
Total	19	27	992

Table 3.9. Inventory of facility radiation monitoring instruments, 1983

Instrument type	Number		Total (Jan. 1, 1984)
	Installed	Retired	
Air monitor, α	1	0	113
Air monitor, β	0	0	154
Lab monitor, α	0	4	176
Lab monitor, β	1	2	230
Monitron	0	0	203
Other	0	0	140
Total	2	6	1016

Table 3.10. Divisional allocation of health physics facility monitoring instruments, 1983

ORNL division	α air monitor	β air monitor	α lab monitor	β lab monitor	Monitron	Other	Total
Analytical Chemistry	9	11	14	20	12	3	69
Chemical Technology	44	29	63	47	44	29	256
Chemistry	7	1	13	14	0	2	37
Metals and Ceramics	15	15	22	12	8	17	89
Operations	24	85	48	91	111	50	409
Physics	2	2	4	15	3	3	29
Others	12	11	12	31	25	36	127
Total	113	154	176	230	203	140	1016

Table 3.11. Calibrations facility résumé, 1983

Item	Number of calibrations
Beta-gamma survey meters	2127
Neutron survey meters	321
Alpha survey meters	806
Personnel dosimeters	1946
Badge dosimetry components	3448

3.2 DEVELOPMENTS

3.2.1 Biometric Estimation of Chest Wall Thickness

Optimal use of whole-body counting data to estimate pulmonary deposition of the actinides depends on accurate measurement of the thickness of the chest wall because of severe attenuation of low-energy X rays and photons associated with the decay of these radionuclides. Algorithms for estimation of female and male chest wall thickness, verified by real-time ultrasonic measurements, have been derived based on correlations of measured chest wall thickness with other common biometric quantities. These algorithms reduce the error generally associated with estimation of internal actinide deposition because the technique eliminates the need to assume an average chest wall thickness for all counting subjects.

3.2.2 Validation of Calibration Factors for Long-Term ^{241}Am Deposition Measurements in Humans

In vivo actinide detection procedures at ORNL have generally been based on an assumption of short-term pulmonary deposition. Recent chronic exposure cases have demonstrated the need for determination of bone deposition as well as lung deposition to assess total dose commitment.

Calibration factors for ^{241}Am in bone were derived empirically for a large hyperpure germanium detector array. To confirm the accuracy of these calibrations, approximately 185 MBq (5 mCi) of ^{241}Am -citrate were administered orally to six domestic Yorkshire swine. Direct thorax and skull measurements were made after ultrasonic determination of the tissue thickness and quality over the skeletal regions of interest. The swine were sacrificed within 24 h of the measurements and the quantity and distribution of activity in each was assessed analytically. The skeletal activity estimated by in vivo measurements compared favorably with the assayed activity, thus indicating the validity of our current method of quantifying ^{241}Am deposition in the human skeleton.

3.2.3 Quality Assurance for the ORNL Pocket Meter Program

A quality assurance process was initiated for the indirect-reading pocket dosimeter program. The dosimeters were charged, leak tested for 24 h, vibrated and drop tested, exposed to 100 mR, and read. A total of 1848 acceptable pocket dosimeters were marked and redeployed into the system to be tracked for six months. Rejection of marked meters during the study was caused primarily by defective electrodes or retainer rings. The study provided data indicating that leakage and false readings are minor problems with pocket dosimeters and concluding that charging a pocket dosimeter correctly is extremely important in obtaining the most accurate response from the dosimeter. As a result of these findings a quality assurance program was initiated and documented, whereby pocket dosimeters are routinely taken out of the system, tested, and put back into the system or repaired.

4. ENVIRONMENTAL MANAGEMENT PROGRAM

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K. L. Daniels	M. A. Montford	E. B. Wagner
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	A. C. Wittmer	

4.1 DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

The Department of Environmental Management (DEM) is mandated to monitor the environmental effects of ORNL operations and the Oak Ridge Reservation to ensure that ORNL complies with all environmental regulations. The DEM's major areas of responsibility include (1) environmental surveillance, (2) environmental protection, (3) environmental assessment, and (4) management of hazardous material and wastes.

4.2 ENVIRONMENTAL MANAGEMENT FUNCTIONS

The major Environmental Management activities during 1983 were

- coordinating the Laboratory's pollution abatement and ORO monitoring programs;
- serving as liaison between the various ORNL groups involved in pollution control, ORNL management, and the UCC-ND Office of Health, Safety, and Environmental Affairs;
- determining the pollutants (radioactive and nonradioactive) to be monitored in effluents and environmental media and the location and frequency of the measurements;
- identifying areas where development work, additional monitoring equipment, and changes in waste disposal practices are required for pollution abatement;
- maintaining adequate records on significant effluents within the installation;
- reviewing (or providing for review) the design, acquisition, and installation of required pollution control equipment;
- preparing environmental assessments for those ORNL construction projects that require them;
- preparing monthly, quarterly, and annual reports on radioactive and nonradioactive effluents as required by UCC-ND management and DOE;
- reviewing ORNL construction projects for environmental impact;

- developing the Resource Management Plan for the U.S. Department of Energy's Oak Ridge Reservation; and
- preparing compliance evaluation inspection responses.

The Department of Environmental Management uses three separate monitoring networks for airborne radioactivity in eastern Tennessee. The local air monitoring (LAM) network consists of 23 stations positioned relatively close to ORNL operational activities; the perimeter air monitoring (PAM) network consists of 11 stations located on the perimeter of the DOE-controlled area and provides data for evaluating the impact of all Oak Ridge operations on the immediate environment; and the remote air monitoring (RAM) network consists of 7 stations located outside the DOE-controlled area at distances of 19 to 121 km (12 to 75 miles) from ORNL (see Figs. 4.1-4.4 in ORNL-5962). These monitoring networks provide for the collection of (1) airborne radioactivity by air filtration techniques, (2) radioparticulate fallout material by impingement on gummed paper trays, (3) rainwater for measurement of fallout occurring as rainout, (4) radioiodine using charcoal cartridges, and (5) tritium using silica gel (selected LAMs). After treatment, low-level radioactive liquid effluents originating from ORNL operations are discharged to White Oak Creek, a small tributary of the Clinch River. The radioactive content of White Oak Creek discharge is determined at White Oak Dam, which is the last control point along the stream before the entry of White Oak Creek into the Clinch River. Water samples are also collected in the Clinch River at several locations, beginning at a point above the entry of the liquid effluent into the river and ending at Kingston Water Plant near Kingston, Tennessee, the nearest population center downstream (see Fig. 4.5 in ORNL-5962).

Samples of White Oak Creek effluent are collected at White Oak Dam by a continuous proportional sampler and analyzed weekly for gross beta, gross alpha, ^3H , ^{90}Sr , all detectable gamma emitters, plutonium, and transplutonium elements. Calculations are made of the concentrations of radioactivity in the Clinch River at the point of entry of White Oak Creek [Clinch River Mile (CRM) 20.8], using the concentrations measured at White Oak Dam and the dilution provided by the river. To verify the calculations, two sampling stations are maintained in the Clinch River below the point of entry of the liquid effluents—one at the Oak Ridge Gaseous Diffusion Plant (ORGDP) water intake (CRM 14.5) and the other at Kingston Water Plant (processed water) at Tennessee River Mile (TRM) 568, which is near CRM 0.0. An additional sampling station is maintained in the Clinch River at Melton Hill Dam (CRM 23.1), which is above the point of entry of the liquid effluents, to provide background data and at the mouth of White Oak Creek (CRM 20.8) for backup measurements of White Oak Dam station.

The ORGDP water sampling station collects a sample from the Clinch River proportional to the flow in the river near the water intake of the ORGDP water system. The samples are brought into the laboratory at weekly intervals; an aliquot is composited for quarterly analysis of tritium and the remaining portion of the sample is concentrated by evaporation and analyzed for gross activity and for individual radionuclides that may be present in significant amounts.

A grab sample of the processed water is collected daily at the Kingston Water Plant sampling station; the samples are composited and analyzed quarterly. The preparation of these samples and the analyses performed are the same as those for the ORGDP water sampling station.

The Melton Hill Dam station collects a sample proportional to the flow of water through the power generating turbines; the sample represents all of the discharge from the dam except for a minor amount discharged in the operation of the locks. Samples are collected from the station weekly and are processed and analyzed in the same manner as for the ORGDP water sampling station.

Samples of ORNL's potable water are collected daily, composited, and stored; at the end of each quarter, these composites are analyzed radiochemically for ^{90}Sr content and are assayed for long-lived gamma-emitting radionuclides by gamma spectrometry.

Raw milk is collected at nine sampling stations located within a radius of 80 km (50 miles) from ORNL. Samples are taken weekly from five stations located outside the DOE-controlled area within a 32-km (20-mile) radius of ORNL (see Fig. 4.6 in ORNL-5962). Samples are collected every five weeks from the four remaining stations located more remotely, out to distances of about 80 km (50 miles) (see Fig. 4.7 in ORNL-5962). The purpose of the milk sampling program is twofold: (1) samples collected in the immediate vicinity of ORNL provide data by which the possible effects of effluents from ORNL operations can be evaluated and (2) samples collected remote to the immediate vicinity of ORNL provide background data essential to establishing a proper index from which releases of radioactive materials originating from Oak Ridge operations may be evaluated. The milk samples are analyzed by radiochemical techniques for ^{90}Sr and ^{131}I . The minimum detectable concentrations of ^{90}Sr and ^{131}I in milk are 18.5 mBq/L (0.5 pCi/L) and 16.7 mBq/L (0.45 pCi/L), respectively.

External gamma radiation background measurements are made routinely at the LAM, PAM, and RAM stations and at one station located near Melton Hill Dam. Measurements are made using lithium fluoride and calcium fluoride thermoluminescent dosimeters (TLDs) suspended 1 m above the ground. Dosimeters at the PAM stations and Melton Hill Dam are collected and analyzed monthly, those at LAM and RAM stations semiannually.

External gamma radiation measurements are also made routinely along the banks of the Clinch River from the mouth of White Oak Creek to points several hundred meters downstream (see Fig. 4.8 in ORNL-5962). These measurements are used to evaluate gamma radiation levels resulting from ORNL liquid effluent releases and "sky shine" from an experimental ^{137}Cs plot located near the riverbank.

Various species of fish that are commonly caught and eaten in eastern Tennessee are taken from the Clinch River quarterly from CRM 20.8 (intersection of White Oak Creek and the Clinch River) and annually from other locations in the Clinch River. Ten fish of each species are composited for each sample, and the samples are analyzed by gamma spectrometric and radiochemical techniques for the critical radionuclides that may contribute significantly to the potential radiation dose to man.

Soil and grass samples are collected semiannually and annually, respectively, from locations near the PAM and RAM stations and semiannually at LAM station 16. The samples are collected, composited, and analyzed by gamma spectroscopy and radiochemical techniques for uranium, plutonium, and various other radioisotopes.

4.2.1 Compliance Evaluation Inspection Response

On August 23, 1983, as required by State and Federal law, a compliance evaluation inspection (CEI) of ORNL was conducted by the Tennessee Department of Health and Environment (TDHE) and the U. S. Environmental Protection Agency (EPA). This was the first time that the Laboratory had been the subject of such an inspection and the first time that ORNL's compliance with the Tennessee Waste Quality and Hazardous Waste Acts had been examined. A report of the State's findings, which was received by DOE/ORO as a notice of noncompliance on November 1, 1983, contained detailed descriptions of what were considered numerous environmental problems. A response was required from DOE/ORO within 30 days of receipt of the notice.

With the cooperation of members of the Waste Management staff and some Environmental Sciences Division (ESD) personnel, the staff of the DEM prepared a two-volume response report that

was transmitted to DOE/ORO on November 23, 1983.¹ Each of the issues raised in the CEI was evaluated item by item, and additional information and data either requested in the CEI or pertinent to the National Pollutant Discharge Elimination System (NPDES) permitting decisions were included. DOE/ORO was able to assemble a complete response to the noncompliance notice by December 1, 1983.

4.2.2 Resource Management Plan

The DEM coordinated the preparation of the 1983 Resource Management Plan (RMP) for the Oak Ridge Reservation (ORR). The project involved the environmental coordinators of the three plants on the ORR as well as 15 working groups made up of experts in the following resource areas: aquatic habitats; archaeological considerations; endangered and threatened plant species; environmental monitoring; forest management; geography, topography, demography, and soils; geology; health, safety, and environmental affairs; hydrology; site development; laws, regulations, and guidelines; national environmental research; utilities; waste management; and wildlife management. A 17-volume Resource Management Plan was published and a permanent Resource Management Committee (RMC) was established to address issues involving resources on the reservation. Two DEM members are extensively involved in the activity, one as a working group chairperson and the other as an RMC subgroup representative and report coordinator.

4.3 ATMOSPHERIC MONITORING

4.3.1 Air Concentrations

The average concentrations of alpha radioactivity in the atmosphere as measured with filters from the LAM, PAM, and RAM networks during 1983 follow.

Network	Concentration	
	Bq/m ³	μCi/cm ³
LAM	0.82E-4	0.22E-14
PAM	0.41E-4	0.11E-14
RAM	0.37E-4	0.10E-14

All networks are less than 11% of 0.74E-3 Bq/m³ (2.0E-14 μCi/cm³), the average concentration guide (CG_a) for a mixture of airborne uranium isotopes in an uncontrolled area.²

The average concentrations of beta radioactivity in the atmosphere as measured with filters from the LAM, PAM, and RAM networks during 1983 follow.

1. Compliance Evaluation Inspection of the Oak Ridge National Laboratory by the TDHE and the EPA, November 21, 1983, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

2. DOE Order 5480.1, Chap. XI.

Network	Concentration	
	Bq/m ³	μCi/cm ³
LAM	0.19E-2	0.51E-13
PAM	0.11E-3	0.30E-13
RAM	0.89E-3	0.24E-13

The LAM, PAM, and RAM network values represent <0.04% of the CG_aU of 3.7 Bq/m³ (1.0E-10 μCi/cm³) applicable to releases to uncontrolled areas.

4.3.2 Fallout (Gummed Paper Technique)

The average activity on gummed paper for the three air monitoring networks for 1983 was 2.5 Bq/m² (6.16E-6 μCi/ft²) as compared to 9.6E-1 Bq/m² (2.4E-6 μCi/ft²) for 1982.

4.3.3 Rainout (Gross Analysis of Rainwater)

The average concentrations of beta radioactivity in rainwater collected from the three networks during 1983 follow.

Network	Concentration	
	Bq/m ³	μCi/cm ³
LAM	0.26E-3	0.70E-8
PAM	0.23E-3	0.63E-8
RAM	0.42E-3	0.11E-7

4.3.4 Atmospheric Radioiodine (Charcoal Cartridge Technique)

Atmospheric iodine sampled at the perimeter stations averaged 0.44E-4 Bq/m³ (0.12E-14 μCi/cm³) during 1983. This average represents <0.002% of the concentration guide of 3.7 Bq/m³ (1E-10 μCi/cm³) applicable to inhalation of ¹³¹I released to uncontrolled areas. The maximum concentration observed for one week was 0.55E-4 Bq/m³ (0.15E-13 μCi/cm³).

The average radioiodine concentration at the local stations was 0.18E-3 Bq/m³ (0.50E-14 μCi/cm³), which is <0.003% of the concentration guide for uncontrolled areas. The maximum concentration for one week was 0.12E-1 Bq/m³ (0.33E-12 μCi/cm³).

In general the level of radioactivity for the specific radionuclides in air for 1983 was lower than the values reported for 1982. This correlated with less fallout in 1983 from weapons testing.

4.3.5 Nonradioactive Air Particulates

Suspended air particulates are measured at air monitoring stations 1, 3, 6, 7, and 15 by the high-volume method recommended by the EPA. The average annual geometric mean of the stations was

34 $\mu\text{g}/\text{m}^3$, which is 45% of the Tennessee Air Pollution Control Regulation's primary standard and approximately the same as the results for previous years.

4.3.6 Milk Analysis

The yearly average and maximum concentrations of ^{131}I in raw milk from the immediate and remote environs were less than the minimum detectable concentration of ^{131}I [17.0 mBq/L (0.45 pCi/L)]. The concentrations of ^{90}Sr in milk from both the immediate and remote environs of ORNL are about the same as reported for 1982 and are within the Federal Radiation Council's range.

4.3.7 ORNL Stack Releases

The radionuclide releases from ORNL stacks are summarized in Table 4.1. In addition to the nuclides reported in Table 4.1, the following were released from Stack 791I: $4.4\text{E}-2$ TBq (1.2 Ci) of ^{212}Pb , $3.0\text{E}+1$ TBq ($8.1\text{E}+2$ Ci) of ^{220}Rn , and $5.1\text{E}-2$ TBq (1.4 Ci) of ^{222}Rn . These releases resulted from processing and storage of a neutron-irradiated ^{226}Ra source.

4.4 WATER MONITORING

4.4.1 White Oak Lake Waters

As shown in Fig. 4.1, the 1983 discharges of tritium to the Clinch River were up from 1982. Table 4.2 shows all of the measured radioisotopes discharged during 1983. Trends in the total CG_w levels in the Clinch River are presented in Fig. 4.2. Water samples for analysis of nonradioactive substances are collected at the same locations as those for radioactive water sampling. All are composited from monthly analyses and analyzed for a variety of water quality parameters related to process release potential and background information needs by analytical procedures recommended by the EPA. Figure 4.3 shows the number of water quality violations of the NPDES permit for the ORNL site.

4.4.2 Potable Water

The average quarterly concentrations of ^{90}Sr in potable water at ORNL during 1983 follow.

The average value of $0.19\text{E}-1$ Bq/L ($0.51\text{E}-9$ $\mu\text{Ci}/\text{mL}$) represents 0.2% of the CG_w for drinking water applicable to individuals in the general population.

Quarter No.	Concentration	
	Bq/L	$\mu\text{Ci}/\text{mL}$
1	$0.42\text{E}-1$	$0.11\text{E}-8$
2	$0.16\text{E}-1$	$0.43\text{E}-9$
3	$0.10\text{E}-2$	$0.27\text{E}-10$
4	$0.16\text{E}-1$	$0.43\text{E}-9$
Average	$0.19\text{E}-1$	$0.51\text{E}-9$

Table 4.1 Annual discharges of radionuclide to the atmosphere

Stack	^3H		^{85}Kr		^{131}I		^{133}Xe		Unidentified alpha	
	TBq	kCi	TBq	kCi	GBq	Ci	TBq	kCi	kBq	μCi
2026					$\leq 4.1\text{E}-3$	$\leq 1.1\text{E}-4$				
3020					$\leq 3.3\text{E}-3$	$\leq 9.0\text{E}-5$				
3039	$7.7\text{E} + 2$	$2.1\text{E} + 1$	340	9.3	≤ 1.4	$\leq 3.7\text{E}-2$	$1.7\text{E} + 3$	$4.5\text{E} + 1$		
7025	30	0.8								
7911			94	2.5	$\leq 5.5\text{E}-1$	$\leq 1.5\text{E}-2$	$4.4\text{E} + 2$	$1.2\text{E} + 1$		
Transuranic										
Laboratory									$1.5\text{E} + 2$	4.1
4508									7.4	0.2
Total	$8.0\text{E} + 2$	$2.2\text{E} + 1$	$4.4\text{E} + 2$	$1.2\text{E} + 1$	≤ 2.1	$\leq 5.3\text{E}-2$	$2.1\text{E} + 3$	$5.7\text{E} + 1$	$1.6\text{E} + 2$	4.3

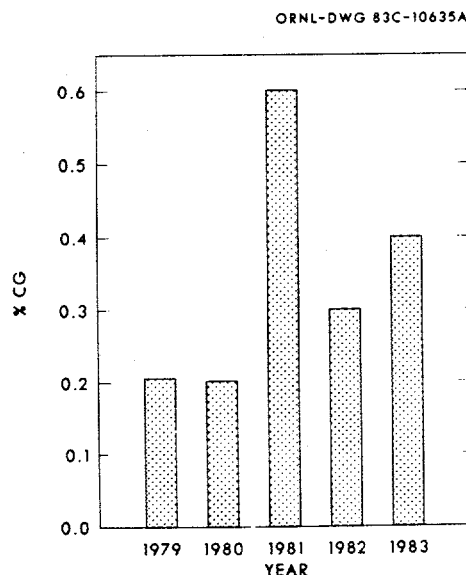


Fig. 4.1. ^3H and ^{90}Sr curies discharged over White Oak Dam.

4.4.3 Clinch River Fish

Results of radionuclide analyses of the fish samples taken in the 1983 fish sampling program showed that the percentage of maximum permissible intake (MPI) was higher than that calculated for 1982 (maximum 1.4% of MPI).³ Calculations of the estimated dose to an adult individual during 1983 from consumption of 16.8 kg of carp taken from CRM 20.8 showed higher total-body and critical organ doses than found in 1982. The concentrations of mercury found in the fish taken from CRM 12.0 (mouth of Poplar Creek) averaged lower than those measured for 1982 with a maximum of 34% of the action level.⁴

4.5 RADIATION BACKGROUND MEASUREMENTS

The data on average external gamma radiation background measurements showed $2.0\text{E}-9$ C/kg/h ($7.8 \mu\text{R/h}$) at remote stations, $2.9\text{E}-9$ C/kg/h ($11 \mu\text{R/h}$) at perimeter stations, and $7.5\text{E}-9$ C/kg/h ($29 \mu\text{R/h}$) at local stations. The difference between the average levels in the perimeter and the remote environs is considered to be within the variation in background normally experienced in eastern Tennessee; the difference is dependent on elevation, topography, and the geological character of the surrounding soil.⁵

3. MPI = intake of radionuclide from eating fish calculated to be equal to a daily intake of 2.2 L of water over a period of one year containing the concentration of radionuclides in question. Consumption of fish is assumed to be 16.8 kg/year of the species in question. Only man-made radionuclides were used in the calculation.

4. Percentage of proposed FDA action level for mercury in fish of 1000 ng/g normally experienced in eastern Tennessee; the difference is dependent on elevation, topography, and the geological character of the surrounding soil.

5. T. W. Oakes, K. E. Shank, and C. E. Easterly, "Natural and Man-Made Radionuclide Concentrations in Tennessee Soil," pp. 323-333 in *Proceedings of the Health Physics Tenth Midyear Topical Symposium, Saratoga Springs, New York, October 11-13, 1976*.

Table 4.2. Discharge of radionuclides to the Clinch River in 1983

⁹⁰ Sr		¹⁰⁶ Ru		¹³⁷ Cs		Alpha ^{TRU?}		³ H		¹³¹ I	
TBq	Ci	TBq	Ci	TBq	Ci	TBq	Ci	TBq	Ci	TBq	Ci
7.8E-2	2.1	6.7E-3	0.18	4.4E-2	1.2	1.8E-3	4.8E-2	2.1E+2	5.6E+3	1.4E-4	3.9E-3

3.53

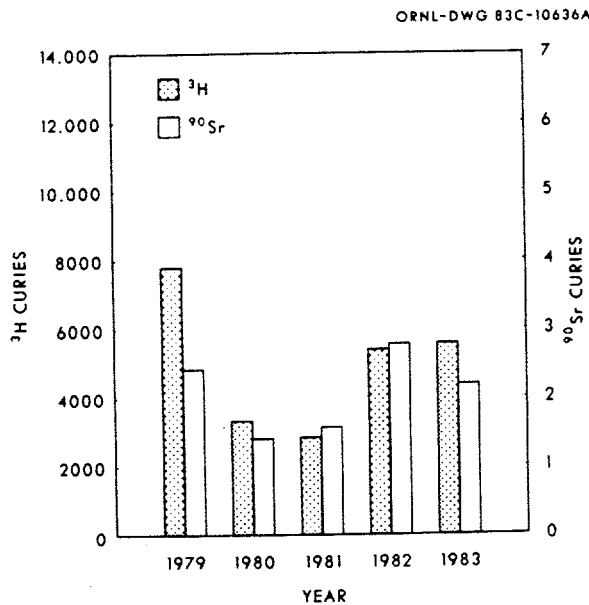


Fig. 4.2. Total CG_w levels discharged over White Oak Dam.

4.6 SOIL AND GRASS SAMPLES

The data on the soil measurements showed no major differences from the data for last year, but the data on grass did show a decrease in ^{90}Sr and ^{137}Cs in both remote and perimeter samples. The most likely cause for the reduction is the decrease in fallout from atmospheric nuclear tests (see Figs. 4.4 and 4.5).

4.7 DEER SAMPLES

Frequently deer are killed by automobiles on the DOE reservation (see Fig. 4.6). Eighty-eight vehicle-killed deer were analyzed during 1983 for gamma emitters. The mean level of ^{137}Cs found in the muscle and liver of the deer killed in the vicinity of the reservation was 2.2 Bq/kg (0.059 pCi/g) to muscle and 1.3 Bq/kg (0.035 pCi/g) to liver. Of those killed at locations remote to the reservation, the mean results are 14 Bq/kg (0.38 pCi/g) to muscle and 3.1 Bq/kg (0.084 pCi/g) to the liver.

4.8 CALCULATION OF POTENTIAL RADIATION DOSE TO THE PUBLIC

Potential radiation doses resulting from plant effluents were calculated for a number of dose reference points within the Oak Ridge environs. All significant sources and modes of exposure were examined, and a number of general assumptions were used in making the calculations. The site boundary for the Oak Ridge complex was defined as the perimeter of the DOE-controlled area.

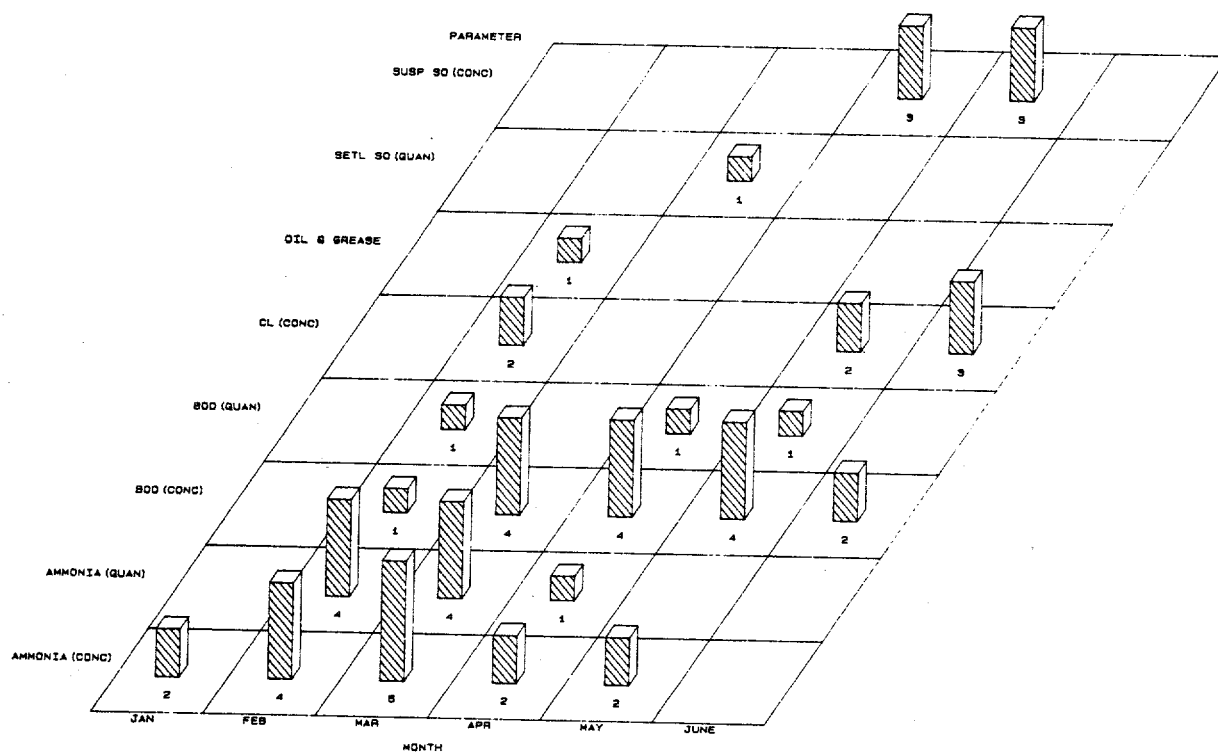
Gaseous effluents are discharged from several locations within ORNL. For our calculations, the gaseous discharges were assumed to occur from only one vent. Concentrations of radionuclides contained in the air and deposited on the ground were estimated at distances up to 80 km (50 miles) from the Oak Ridge facilities using a Gaussian plume model developed by Pasquill⁶ and Gifford⁷ incorporated in

6. F. Pasquill, *Atmospheric Diffusion*, D. Van Nostrand Co., Ltd., London, 1962.

7. F. A. Gifford, Jr., *The Problem of Forecasting Dispersion in the Lower Atmosphere*, U.S. AEC, DTI, Oak Ridge, Tenn., 1962.

FREQUENCY BLOCK CHART

ORNL-DWC 84-10351



FREQUENCY BLOCK CHART

ORNL-DWC 84-10350

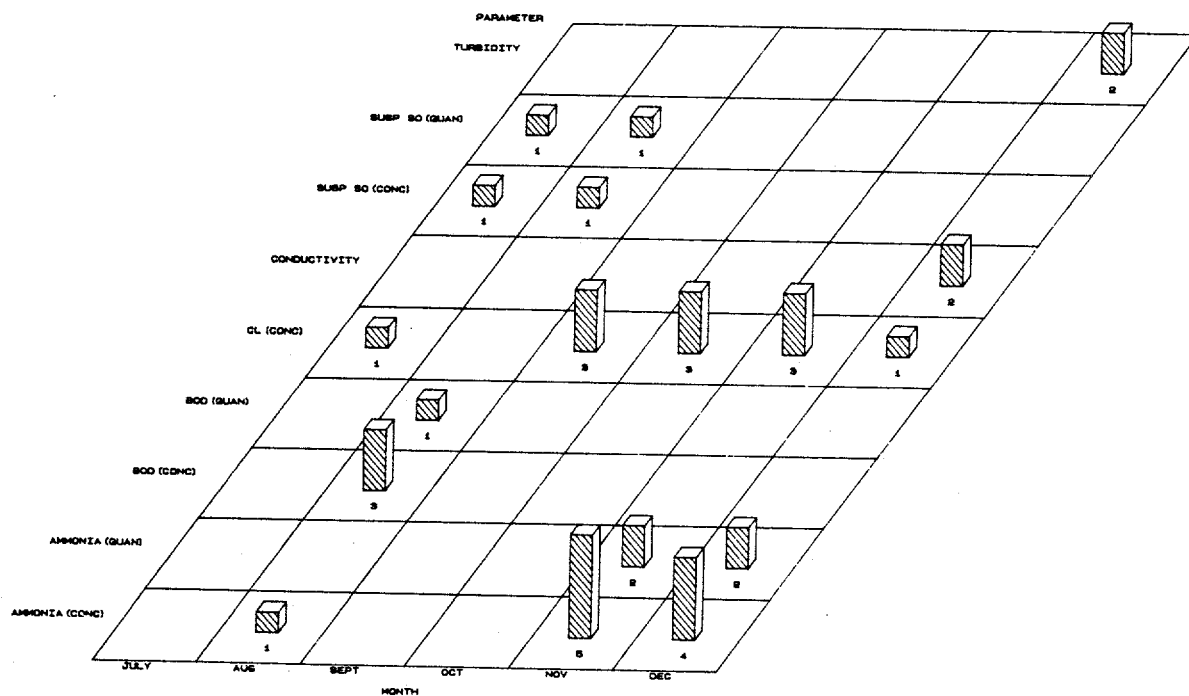


Fig. 4.3. NPDES discharge permit violations in 1983.

RADIONUCLIDES IN SOIL SAMPLES FROM
PERIMETER AND REMOTE MONITORING STATIONS
1983

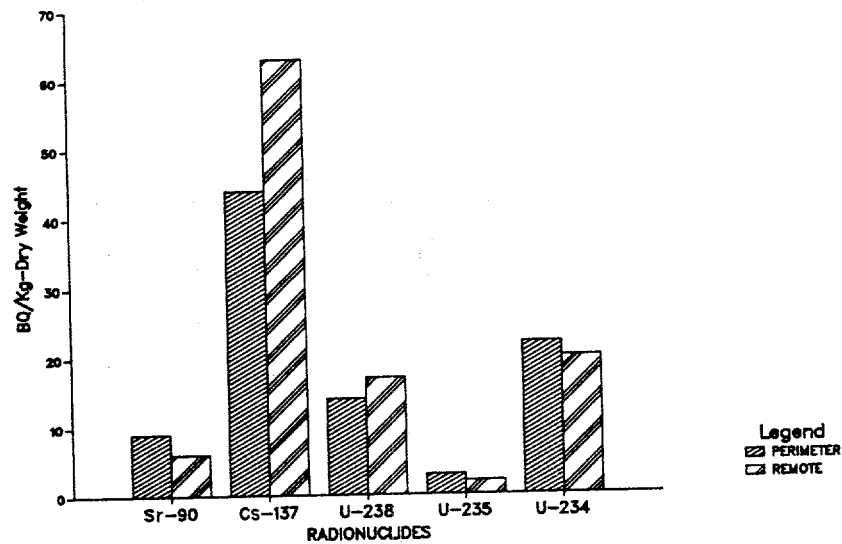


Fig. 4.4. Radionuclides in soil samples.

RADIONUCLIDES IN GRASS SAMPLES FROM
PERIMETER AND REMOTE MONITORING STATIONS
1983

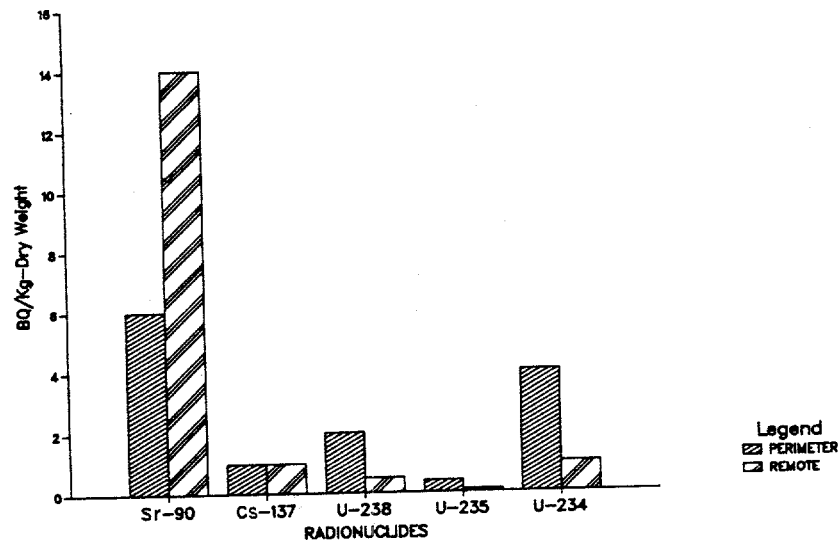


Fig. 4.5. Radionuclides in grass samples.

ROAD-KILLED DEER

ORNL-DWG. 84-10369

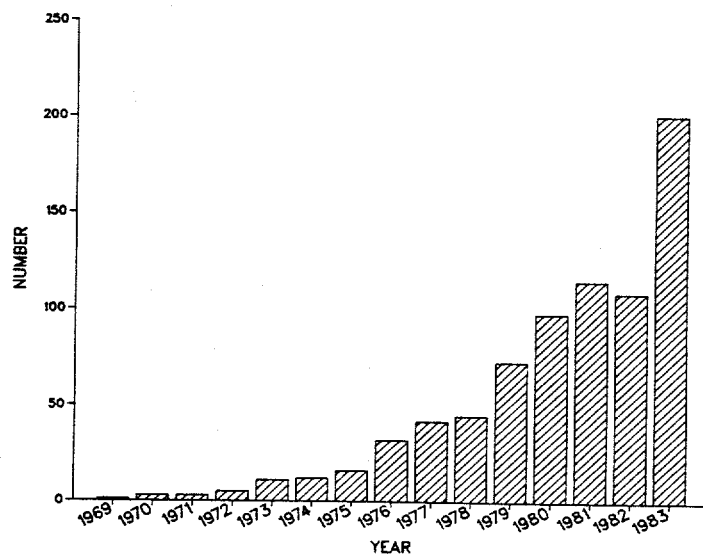


Fig. 4.6. Road-killed deer trends.

the computer program AIRDOS.⁸ The concentration was averaged over the crosswind direction to give the estimated ground-level concentration downwind of the source of emission. The deposition velocities used in the calculations were 0.0 cm/s for krypton and xenon, 0.2 cm/s for iodine, and 0.1 cm/s for particulates. Potential dose commitments due to gaseous effluents from ORNL were calculated by using the intake values from AIRDOS in the DARTAB⁹ and RADRISK^{10,11} computer programs.

Exposures to radionuclides originating in other effluents released from the ORNL facilities were converted to estimates of radiation dose to individuals using models and data presented in publications of the International Commission on Radiological Protection, other recognized literature on radiation protection, personal communication, and computer programs incorporating some of these models and data. Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until it is removed by processes of metabolism and radioactive decay; thus, the estimates for internal dose are called dose commitments. They are obtained by integration over an assumed lifetime of the exposed individual.

8. R. E. Moore et al., *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides*, EPA 520/1-79-009, U.S. EPA, Washington, D.C., 1979.

9. C. L. Begovich et al., *DARTAB: A Program to Combine Airborne Radionuclide Environmental Exposure Data with Dosimetric and Health Effects Data to Generate Tabulations of Predicted Health Impacts*, ORNL-5692, Oak Ridge National Laboratory, 1981.

10. D. E. Dunning, R. W. Leggett, and M. G. Yalcintas, *A Combined Methodology for Estimating Dose Rates and Health Effects from Exposure to Radioactive Pollutants*, ORNL/TM-7105, Oak Ridge National Laboratory, 1980.

11. R. E. Sullivan et al., *Estimates of Health Risk from Exposure to Radioactive Pollutants*, ORNL/TM-7745, Oak Ridge National Laboratory, 1981.

Radiation doses to the total body and to internal organs from external exposures to penetrating radiation are approximately equal; however, doses to individual organs from ingested or inhaled radionuclides may vary considerably because some radionuclides concentrate in certain organs. For this reason, in estimating radiation dose to the total body, thyroid, lungs, bone, liver, kidneys, gastrointestinal tract, and other organs, various pathways of exposure were considered. These estimates were based on parameters applicable to an average adult. The population dose estimate [person-Sv (person-rem)] is the sum of the total-body doses to exposed individuals within an 80-km (50-mile) radius of the Oak Ridge facilities.

4.8.1 Maximum Potential Exposure

The point of maximum potential exposure ("fence-post" dose) on the site boundary is located along the bank of the Clinch River adjacent to a cesium field experimental plot and is due primarily to "sky shine" from the plot. A maximum potential whole-body dose of 2.5 mSv/year (250 mrem/year) was calculated for this location assuming that an individual remained at this point for 24 h/d for the entire year. The calculated maximum potential exposure is 50% of the allowable standard.¹² This is an atypical exposure location, and the probability of an exposure of the magnitude calculated is considered remote since access is only by boat.

The total-body dose to a hypothetical maximum exposed individual at the same location was calculated using a more realistic residence time of 240 h/year. Under these conditions the dose was 68 μ Sv/year (6.8 mrem/year), which is 1.4% of the allowable standard and represents a probable upper limit of exposure. A more probable exposure potential might occur at other locations beyond the site boundary as a result of airborne or liquid effluent releases.

The dose commitment to an individual continuously occupying the residence nearest the site boundary would result from inhalation and ingestion of gaseous discharges from ORNL; an inhalation rate of $2\text{E}+4$ L/d for the average adult is used. Calculated dose commitments at this location were 2.3 μ Sv (0.23 mrem) to the pulmonary tissues (the critical organ) and 1.4 μ Sv (0.14 mrem) to the weighted sum; ^3H is the important contributing radionuclide. These levels are 0.02% and 0.03%, respectively, of the allowable annual standard.

One important contribution to dose from radioactivity within the food chain comes from the atmosphere-pasture-cow-milk pathway. Measurements of two principal radionuclides entering this pathway, ^{90}Sr and ^{131}I , indicate that the maximum dose to an individual in the immediate environs from ingestion of 1 L/d of milk is 0.1 μ Sv (0.01 mrem) to the total body and 3.0 μ Sv (0.3 mrem) to the bone. Average concentrations for the remote stations were assumed to be background and were subtracted from the perimeter station data in making the calculations.

The public water supply closest to the liquid discharges from the Oak Ridge facilities is located about 26 km (16 miles) downstream at Kingston. Treated river water samples at Kingston indicate that all measurements of isotopes were about the same as background radiation in untreated water taken from Melton Hill Lake.

Estimates of the 50-year dose commitment to an adult were calculated for consumption of 16.8 kg (37 lb) of fish per year from the Clinch River. This amount, about 2.5 times the national average fish consumption, is used because of the popularity of fishing in eastern Tennessee. From the analysis of edible parts of the fish examined, the maximum organ dose commitment to an individual from the carp samples taken from CRM 20.8 is estimated to be 0.41 mSv (41 mrem) to the bone from ^{90}Sr . The

12. DOE Order 5480, Chap. XI.

maximum total-body dose to an individual was calculated to be 1.5 μSv (0.15 mrem) from ^{137}Cs . These doses are 2.7% and 0.03%, respectively, of the allowable standard. Shad at CRM 20.8 had the highest levels of the most significant isotopes. The fish are not normally consumed by humans, but the maximum hypothetical doses were calculated to be 0.59 mSv (59 mrem) to the bone and 39 μSv (3.9 mrem) to the total body. Fish samples taken from above Melton Hill Dam were analyzed to determine background conditions.

If the fish bones were consumed, the projected dose commitments would be higher than those shown in this report. Strontium concentrates in the bone and preliminary test results indicate that the dose commitment from eating 1 kg (2.2 lb) of fish with bone would be greater by a factor of 3 to 30 times that from eating an equal amount of boneless fish. This possibility is of interest because commercial fishermen may catch carp that are then processed into fish patties which include the bone.

Summaries are given in Table 4.3 of the potential radiation doses to adults in the general public at the points of highest potential exposure from gaseous and liquid effluents from the Oak Ridge facilities.

4.8.2 Dose to the Population

The Oak Ridge population received the largest average individual total-body dose as a population group. The average yearly weighted sum dose to an Oak Ridge resident was estimated to be 0.7 μSv (0.07 mrem), compared with about 1 mSv (100 mrem) from natural background radiation; the average dose commitment to the pulmonary tract of an Oak Ridge resident was 0.001 mSv (0.11 mrem). The maximum potential dose commitment to an Oak Ridge resident was calculated to be 1.4 μSv (0.14 mrem) to the pulmonary tract, about 0.03% of the allowable annual standard.

The cumulative weighted sum dose to the population within an 80-km (50-mile) radius of the Oak Ridge facilities resulting from 1983 plant effluents was calculated to be 0.18 person-Sv (18 person-rem). This dose may be compared with an estimated 87,000 person-rem to the same population resulting from natural background radiation. About 10% of the collective 80-km population dose from the effluents of the Oak Ridge facilities is estimated to be absorbed by the Oak Ridge population.

4.9 MAJOR ACTIVITIES OF THE DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

4.9.1 Environmental Data Assessment Group

The Environmental Data Assessment Group is responsible for assembling, processing, assessing, and reporting the major portion of the environmental monitoring data within ORNL plant boundaries as well as data for off-site monitoring of the Oak Ridge Reservation. This includes the processing of data for 46,000 analyses on 31,000 samples annually. Table 4.4 shows a summary of a majority of the routine samples for which data were processed and reported.

The group is responsible for developing QA procedures for all aspects of the monitoring program including field sampling, laboratory analyses, data entry and verification, and reporting. Added emphasis has been placed upon the quality assurance of the environmental instrumentation; an individual has been assigned to coordinate the repair, calibration, and modification of all instruments and to recommend replacement instrumentation.

The QA of data entry and verification involves the use of a commercial software package for direct key-to-disk entry, full-screen editing, and rekey verification. The DEM is now using a series of

Table 4.3. Summary of estimated radiation dose to an adult during 1983 at locations of maximum exposure

Pathway	Location	Dose [μSv (mrem)]	
		Total body	Critical organ
Gaseous effluents			
Inhalation, direct radiation from air and ground, and food chains	Nearest resident to site boundary	1.4 (0.14) ^a	2.3 (0.23) (pulmonary)
Terrestrial food (milk only)	Milk sampling stations (⁹⁰ Sr)	0.1 (0.01)	3 (0.3) (bone)
Liquid effluents			
Aquatic food chains (fish)	Clinch-Tennessee River System (⁹⁰ Sr and ¹³⁷ Cs)	1.5 (0.15) ^b	410 (41) (bone)
Drinking water ^b	Kingston, Tennessee ^c (⁹⁰ Sr)		
Direct radiation			
Water, shores, and mud flats ^d	Downstream from White Oak Creek near experimental Cs field plots	68 (6.8)	68 (6.8) (total body)

^aDose commitment to the weighted sum of organs, equivalent to the risk from a uniform total-body irradiation calculated by methods recommended by the ICRP:

- *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 26, Pergamon Press, Oxford, 1977;
- *Limits for Intakes of Radionuclides by Workers*, ICRP Publication 30, Report of Committee 2 of ICRP, Pergamon Press, Oxford, 1978.

^bBased on analysis of processed water.

^cAll isotopes in the treated Kingston water were less than in the untreated background water taken from Melton Hill Lake.

^dAssuming a residence time of 240 h/year.

programs for electronically transferring data from ORNL's Analytical Chemistry Division to a centralized database for statistical analysis and report preparation.

The group is responsible for the design and implementation of an environmental monitoring information system (EMIS) that will combine and integrate DEM's numerous data resources into a single centralized database from which statistical analyses, graphics, and reports can be easily generated.

Table 4.4. Environmental monitoring on the Oak Ridge Reservation

Type	Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
Air	39	Continuous	Weekly	Weekly	Gross alpha, gross beta, rainout, ^{131}I , ^3H
	3	Continuous	Weekly	Quarterly	Specific radionuclides
	22	Continuous	Continuous	Continuous	Fallout beta-gamma, alpha
	5	24 h	Bimonthly	Bimonthly	Suspended particulates
	39	Continuous	Continuous	Continuous	Gross particulate beta-gamma
Stack releases	8	Continuous	Weekly	Weekly	Gross alpha, ^a gross beta, ^a 8-d gross alpha, ^b 8-d gross beta ^b ^{131}I
	1	Continuous	3 times/week	3 times/week	
	1	Continuous	Weekly	Weekly	Gross alpha, gross beta, ^3H , ^{90}Sr , ^{60}Co , ^{106}Ru , ^{137}Cs , ^{238}Pu , transplutonium
Stream water	4	Grab	Monthly	Monthly	Cr, Zn, $\text{NO}_3(\text{N})$, Hg
	1	Continuous	Weekly	Monthly	Gross alpha, ^3H , ^{60}Co , ^{137}Cs , ^{106}Ru
	1	Continuous	Continuous	Continuous	Gross beta-gamma
	1	Continuous	Weekly	Monthly	^{238}U , Pb, SO_4 , TDS, Cd, Cr, Gm,
	2	Continuous	Weekly	Quarterly	$\text{NO}_3(\text{N})$, Zn, F, Hg, Ni
	1	Continuous	Weekly	Bimonthly	^{90}Sr , ^{60}Co , ^{137}Cs , ^3H
	1	Grab	Daily	Quarterly	Hg
					^3H , ^{60}Co , ^{137}Cs , ^{90}Sr , gross alpha, gross beta
	1	Daily	Daily	Daily	pH, Cl, flow
	2	Daily	Daily	Daily	pH, DO , ^c temperature, flow
Discharge water (NPDES)	1	Weekly	Weekly	Weekly	Volatile solids, suspended solids

Table 4.4 (continued)

Type	Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
Fish	3	Weekly	Weekly	Weekly	Settleable solids, BOD, ^d suspended solids, NH ₄ , COD, Cr
	1	Monthly	Monthly	Monthly	NH ₄ , kjeldahl nitrogen, fecal coliform
	2	Monthly	Monthly	Monthly	Total dissolved solids, oil, grease
	4	Annually	Annually	Annually	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ⁴⁰ K, ²³⁸ Pu, ²³⁹ Pu, ²³⁴ U, ²³⁵ U, ²³⁸ U, Hg, PCB
Soil	2	Quarterly	Quarterly	Quarterly	⁹⁰ Sr, ¹³⁷ Cs, ⁶⁰ Co, ⁴⁰ K, ²³⁸ Pu, ²³⁹ Pu, ²³⁴ U, ²³⁵ U, ²³⁸ U, Hg, PCB
	10	Semiannually	Semiannually	Semiannually	⁹⁰ Sr, ¹³⁷ Cs, Pu, U, gamma
	8	Annually	Annually	Annually	⁹⁰ Sr, ¹³⁷ Cs, Pu, U, gamma
	17	Annually	Annually	Annually	U, fluoride
Grass	10	Semiannually	Semiannually	Semiannually	⁹⁰ Sr, ¹³⁷ Cs, Pu, U, gamma
	8	Annually	Annually	Annually	⁹⁰ Sr, ¹³⁷ Cs, Pu, U, gamma
	17	Annually	Annually	Annually	U, fluoride
Deer	As available	As available	As available	As available	¹³⁷ Cs, ⁴⁰ K, ⁹⁰ Sr, Hg
Milk	5	Weekly	Weekly	Weekly	⁹⁰ Sr, ¹³¹ I
	4	Bimonthly	Bimonthly	Bimonthly	⁹⁰ Sr, ¹³¹ I
Honeybees	4	Annually	Annually	Annually	¹³¹ I, gamma
TLDs ^e	1	Weekly	Weekly	Weekly	External gammas
	23	Monthly	Monthly	Monthly	External gammas

Table 4.4 (continued)

Type	Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
Groundwater	199	Quarterly	Quarterly	Quarterly	External gammas
	115	Semiannually	Semiannually	Semiannually	External gammas
	54	Annually	Annually	Annually	External gammas
	50	Quarterly	Quarterly	Quarterly	^3H , ^{90}Sr , ^{137}Cs , ^{60}Co , COD, ^f TSD, ^g anions
	12	Quarterly	Quarterly	Quarterly	Metals, volatile organics, pesticides, kjeldahl nitrogen, NH_3 , TOC, ^h oil, grease phenols, PAH ⁱ , BOD, fecal coliform, asbestos
Wastewater	12	Grab	Daily	Monthly	^{90}Sr , gross alpha, gross beta, gamma scan
	1	Grab	Monthly	Monthly	Gross alpha, gross beta, gamma scan
	7	Grab	Monthly	Monthly	Hg, NO_3 , P, Zn, Cr
	3	Grab	Quarterly	Quarterly	^{137}Cs , ^{60}Co , gamma scan

^aSamples are counted within 24 h of collection.^bSamples are recounted after an 8-d decay period.^cDO = dissolved oxygen.^dBOD = biochemical oxygen demand.^eTLD = thermoluminescent dosimeters.^fCOD = chemical oxygen demand.^gTDS = total dissolved solids.^hTOC = total organic carbon.ⁱPAH = polycyclic aromatic hydrocarbons.

The information system will cover five major areas: (1) centralization of data; (2) QA of data; (3) sample and inventory tracking; (4) analysis, graphics, and report preparation; and (5) documentation. A major portion of the Department's data is being processed by ORNL's SAS (Statistical Analysis System). During the report period, several databases were transferred to this system, three group members and others in the department received training in operating the SAS, and two new terminals and a color graphics plotter were obtained to help implement the unified system.

The EMIS will be used by environmental staff at all DOE/ORO plants. The objective of this system is to provide quality data, analyses, and reports to multiple users in a timely manner. The tasks involved in the development include (1) selection and acquisition of hardware and software, (2) development of a user interface, and (3) documentation and training.

The hardware selected by the DEM is a VAX 11/750 virtual memory computer that will act as host and process data sent to it by two data concentrators (PDP 11/44) that will collect real-time data from over 60 stations at the DOE/ORO plants and on the Oak Ridge Reservation (Fig. 4.7).

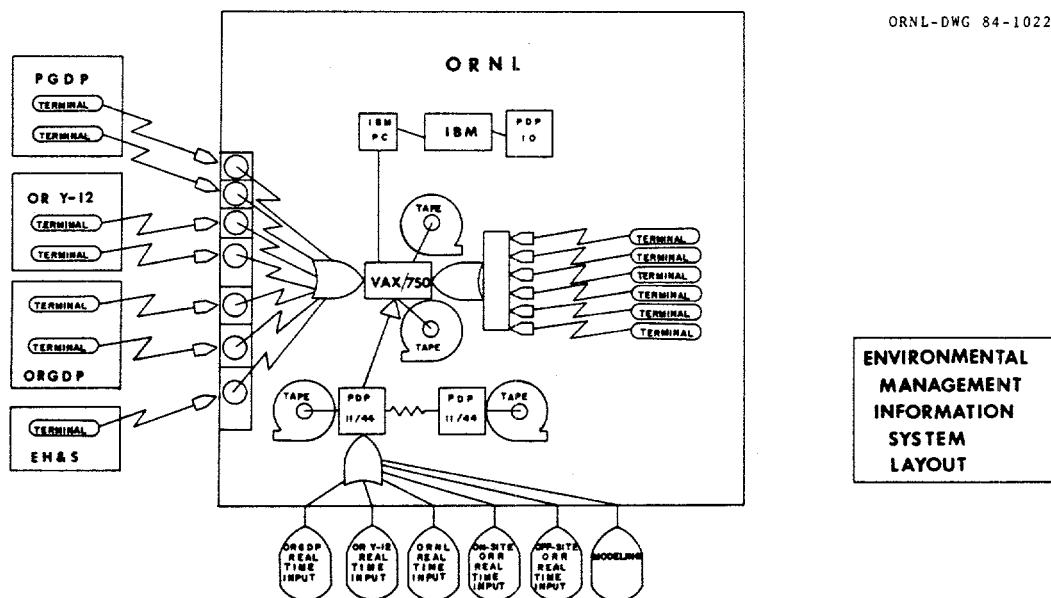


Fig. 4.7. Environmental management information system layout.

Software selected to date includes FORTRAN, SAS, and EasyEntry. FORTRAN will be used for special and unique applications, for communications, and for some modeling programs. SAS was selected for numerical data management because it is a complete software system that can be used for utility functions, report writing, data management, programming, computer performance evaluation, and graphics. It is also the leader in statistical analysis software. EasyEntry is a software package that allows the user to develop forms for entering, verifying, and editing data. It requires no programming knowledge and provides for quality assurance checking during data entry. Its command language can also be used to develop user-friendly menus.

The information system will contain databases on environmental monitoring, laws and regulations, hazardous materials, chemical information, environmental and engineering projects and schedules, and

information collected by the Oak Ridge Task Force and the Resource Management Committee for the Oak Ridge Reservation. It will also contain bibliographies and abstracts of pertinent references (Fig. 4.8).

During the past year, the group took over responsibility for preparing action description memoranda (ADMs). These reports, which are environmental evaluations of GPP and line item projects, contain analyses of the potential environmental impacts of construction, operation, and decommissioning of the projects. ADMs also include environmental assessments of alternatives to the proposed projects.

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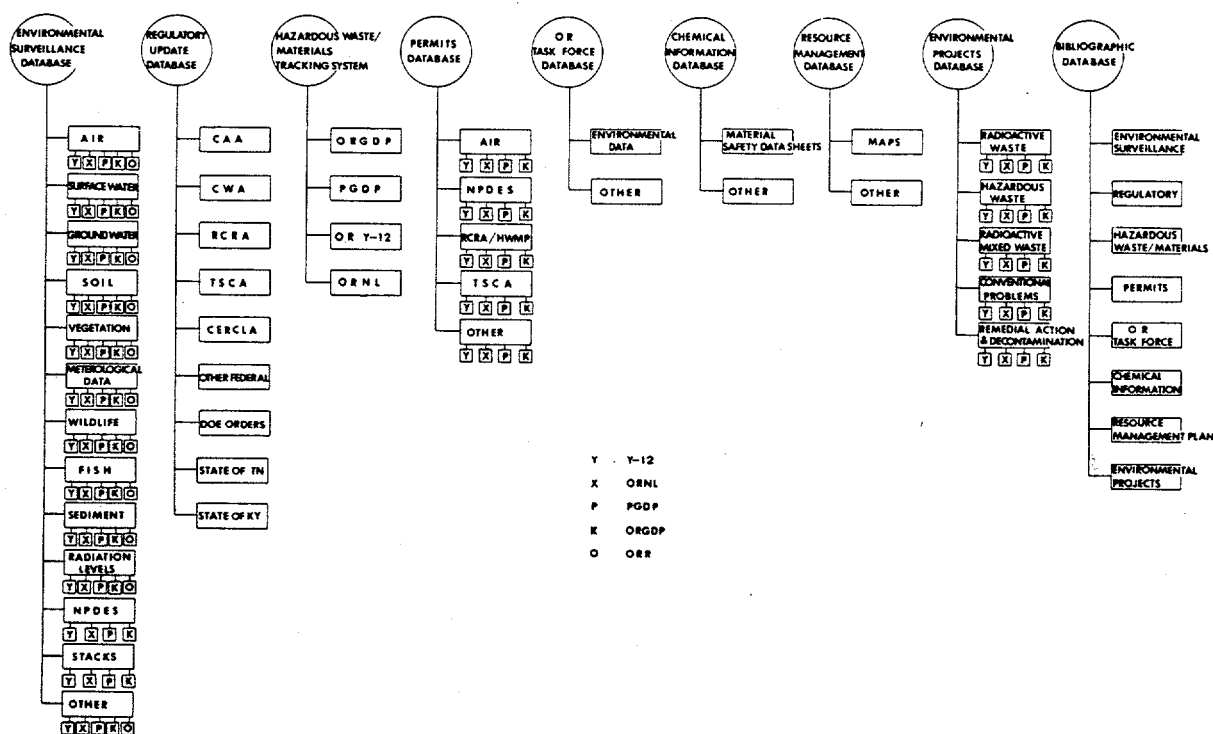


Fig. 4.8. Environmental management information system.

The group was involved in a number of special projects during the reporting period. A major project was the Y-12 stack sampling program. With the assistance of a consulting team from the University of Tennessee, a program was designed to characterize the flow and sampling characteristics of the stacks, instrumentation was obtained, and individuals were trained to sample the stacks. Sampling was begun and a member of the group is coordinating and providing technical assistance for this phase of the project. Other group members have been involved in the development of computer programs and analysis of the data.

In preparation for its regulation of radioactive discharges into the air, the EPA has made preliminary calculations of the dose commitments due to each of the Oak Ridge Operations facilities

including ORNL, Y-12, Feed Materials Production Center, Paducah Gaseous Diffusion Plant, and Goodyear Atomic Corporation. At the request of DOE, the air dispersion and dose commitment computer codes (AIRDOS and DARTAB) were used by the group to compare results obtained by EPA and to make additional runs when more refined input data became available. The group developed of a computer code that combines AIRDOS and DARTAB input, provides additional program documentation, and simplifies execution.

4.9.2 Environmental Engineering Group

The Environmental Engineering Group has two major functions—the engineering and the Y-12 liaison. The main responsibility of the engineering function is to coordinate input to all ORNL divisions and to the Engineering Division regarding the potential environmental impact of proposed projects (i.e., providing criteria and technical review and generating and submitting permit applications). The Y-12 liaison function is to coordinate all DEM activities for the ORNL facilities located at the Y-12 Plant. The group also provides major input to planning and assists other groups within the department.

The group's activities in 1983 were concentrated in four general areas: (1) developing discharge inventories and updating discharge routing drawings to ensure that all waste streams are being handled appropriately; (2) responding to regulatory bodies [(particularly the EPA and the Tennessee Department of Health and Environment (TDHE)] regarding the impact of ORNL's operation on the environment; (3) departmental planning to develop a comprehensive approach for solutions to ORNL's environmental problems; and (4) generating descriptions, justifications, and criteria to convert planned solutions into defined projects which can be then submitted for funding.

(1) The development of discharge inventories took a variety of forms at the various ORNL facilities. Comprehensive surveys were conducted for air and water discharges from ORNL facilities located at the Y-12 Plant. The air surveys were used to fill out air discharge permit applications for the facilities. Water usage and discharge surveys were performed to provide input to Y-12's NPDES permit application.

In addition to the inventories, a great deal of effort was spent to update the drainage drawings for ORNL facilities at Y-12, both within and outside the buildings. In particular, the sanitary drainage system was field-checked to identify any nonsanitary sources of wastewater connected to it. Any such connections found were rerouted to their proper drainage system. Outside the buildings, the combined storm/process sewer system was mapped and new drainage drawings prepared.

At the main ORNL complex, similar surveys have been started. Each chemistry laboratory at ORNL is being visited to ascertain the activity that takes place, what chemicals (radioactive and nonradioactive) are used, the routes of discharge for gases and liquids, and the way those routes reach the environment. As the information is collected, it is being placed in a form suitable for creating a computerized database. Both the surveys and the development of the database are ongoing efforts. When the database is completed, it will be periodically updated as routine inspections take place.

Work on documenting the current state of ORNL's drainage systems proceeded during 1983. The storm drainage system in Melton Valley was mapped for the first time. Work also began in the development of a new atlas for the process drainage system. The atlas is being placed in a digitized format on the Computer Sciences Division's Geographics Department computer. This work should be completed in 1984.

(2) During 1983, the group provided substantial input to compliance reports from the EPA and/or the TDHE: (a) a report of noncompliance on ORNL's silver recovery system and (b) the compliance order imposed on the Y-12 Plant.

The group coordinated the Department's input to the Y-12 Plant regarding wastewater discharges so that Y-12 had all information necessary from ORNL to respond to DOE per their mandated schedule. This effort included the discharge inventories mentioned previously, but also included developing and implementing a sampling and analysis program of all ORNL wastewater discharge points and establishing plans to treat or eliminate all wastewater that ORNL generates.

Finally, in response to TDHE and EPA comments, the group coordinated the development of an underground injection permit application for ORNL's Hydrofracture Facility.

(3) The area of planning was an active one for the group during 1983. The long-range environmental project plan was issued early in the year. Substantive revisions were prepared in response to the concerns raised by the TDHE and the EPA. This plan documents the scope and justification for each project and describes how it fits into ORNL's overall environmental planning and is now being used as a basis for all future funding submittals for expense projects, General Purpose Equipment (GPE), General Plant Projects (GPP), and line item requests.

In addition to the project plan, the group prepared numerous other planning studies in support of Department and Division activities, such as (a) developing the overall plan for the sampling and analysis program to characterize candidate Surplus Facility Management Program sites; (b) coordinating the preparation of the Division's Telecommunications Long-Range Plan; (c) coordinating an Engineering Division study of potential sites for ORNL's new Industrial Landfill and Borrow Area; and (d) generating a development plan for the new Hazardous Waste Management Area being opened up with the Hazardous Waste Storage Facility project. This last document is being formalized by the Engineering Division into a full-scale development plan for the site.

(4) 1983 proved to be an extremely busy year for both funded and planned projects. Using expense funding, the following problems were resolved: (a) a cyanide removal process was added to ORNL's silver recovery system, which brought the system into full compliance with best available technology guidelines for the photographic processing industry; (b) construction began on a new waste chemical room for the Biology complex, which will resolve safety concerns with the current storage room; (c) 500 PCB-containing capacitors were shipped to the University of Wisconsin for use in their program, which solved a storage problem at the Y-12 Plant; and (d) the chemical supply area in the Biology Division was cleaned out, with all chemicals beyond their expiration date removed for disposal.

Numerous instrumentation projects were either initiated or in progress during 1983 (see Fig. 4.9). The replacement of the perimeter air monitoring system, a GPE project, showed progress—necessary funding approved, new sites located, all components procured, and construction of new stations beginning. Similar progress also took place on the new 3039 stack monitoring system, a part of an FY 81 Waste Management line item. The design of the monitoring system was completed in 1983, and procurement of major components has begun.

Work commenced on three new water monitoring stations at White Oak Creek (Weir #3), Melton Branch (Weir #4), and White Oak Dam (Weir #5). ORNL's Instrumentation and Controls Division began the design of a new, highly sensitive beta radioactivity monitor and a gamma spectrometer for use in these areas. Also included in the design is monitoring for a host of nonradiological water quality parameters. These monitors will be completed during 1984.

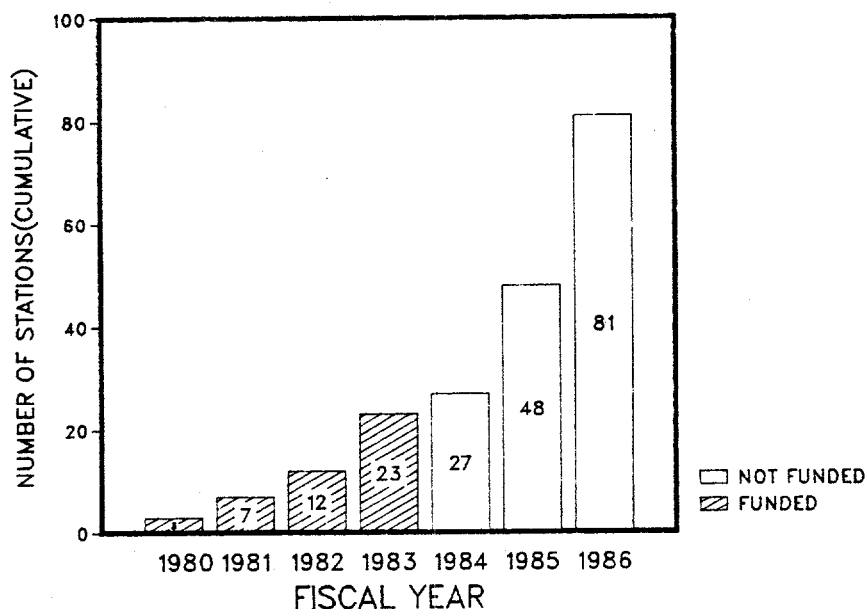


Fig. 4.9. Projected environmental monitoring stations.

The group also developed a comprehensive criteria document for all environmental monitors needed at the Laboratory that became the basis on which the conceptual design reports for the proposed line items "Environmental Monitoring Systems Upgrade, Phases I and II," were developed. These requests have been submitted for FY 85 and 86 funding, respectively.

There was progress on a number of new wastewater treatment systems. The group assisted the Engineering Division in developing a criteria document for the new sewage treatment plant for the Laboratory. In addition, the group participated in a critique of the existing Coal Yard Runoff Treatment System and of the plans to improve it. This critique has led to the proposal of an FY 84 GPP to install a state of the art treatment system. The group also sponsored studies in the Engineering Division for two treatment systems handling wastes from facilities located at Y-12: the Biology area and the Isotope Separations Facility.

A project to correct rainwater inflow and groundwater infiltration problems into ORNL's sanitary sewer system was submitted for FY 84 funding. Work in this area will continue during 1984. Proposals are also in preparation to modify certain process sewers to route their waste to a single collection point in anticipation of a future nonradiological treatment system.

The group is coordinating a series of projects to improve the handling, treatment, and disposal of hazardous materials. A project currently funded is the Hazardous Waste Storage Facility, a storage warehouse under construction for full drums of hazardous waste (an FY 82 GPP). The group was involved in several areas in support of this project, especially assisting in the preparation of the required operation permit application. All technical issues have been resolved, but construction has been stopped until the question of who the operator of the facility will be is resolved.

Preliminary design work also proceeded on the Chemical Waste Storage Facility, an FY 84 GPP to construct a building with areas for handling and storing small quantities of incompatible wastes. The directive for this project has been issued and the architect-engineer selected.

The group developed plans in conjunction with the Hazardous Materials Control Group for a number of additional facilities including buildings dedicated for recycling and recovery of wastes, long-term storage for mixed waste (both radioactive and hazardous), disposal of excess or leaking gas cylinders, and an area where explosives or shock sensitive chemicals can be safely detonated (see Fig. 4.10). These projects will be proposed for GPP funding in FY 85 and beyond.

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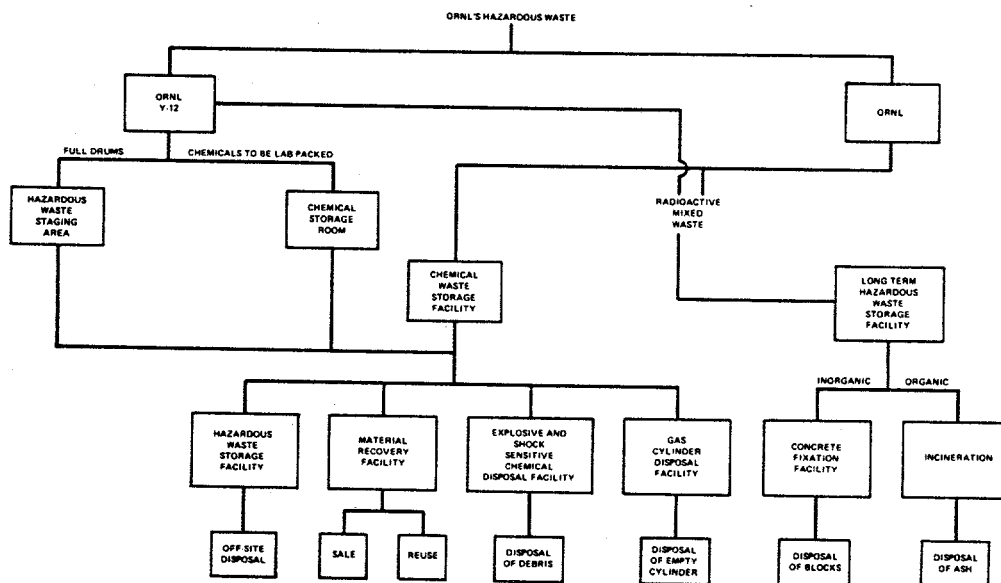


Fig. 4.10. ORNL's hazardous waste disposal schematic.

There were a number of special projects the group was able to assist the Department with covering a broad spectrum of activities where the group had useful expertise, such as (a) assisting the Department in responding to a number of major spills/releases which occurred, especially when high levels of radioactivity began to appear at ORNL's Sewage Treatment Plant; (b) representing the Department on the Radioactive Operations Committee; (c) working with the Engineering Division to determine the impact of EPA's implementing best available technology criteria on ORNL's stack discharges; (d) preparing an appendix to the Oak Ridge Reservation's resource management plan on the subject of waste management; (e) participating in a variety of audits, particularly those conducted by Union Carbide Corp. before their contract's expiration and by Martin Marietta prior to taking over the contract; and (f) coordinating the preparation of a permit for a pump and haul operation for the Clark Center Recreational Park's new sewage system.

4.9.3 Environmental Surveillance Group

The Environmental Surveillance Group of the DEM provides technical, field, and laboratory support for environmental monitoring and sampling activities. This group is responsible for collection of hundreds of environmental samples, acquisition of field data, laboratory preparation of samples (e.g., air, rainwater, surface water, groundwater, particulate matter, milk, soil, vegetation, insects, fish, and deer). The sampling frequency ranges from daily to annually, depending on the environmental

media and the monitoring parameters, which include radioactive and nonradioactive parameters, and thousands of data points result from sample analysis (see Figs. 4.11 and 4.12). Other data points result from field data, real-time monitoring, and constant monitoring, and the parameters include pH, flow, radiation levels, radionuclides, chlorine, temperature, dissolved oxygen, conductivity, and turbidity.

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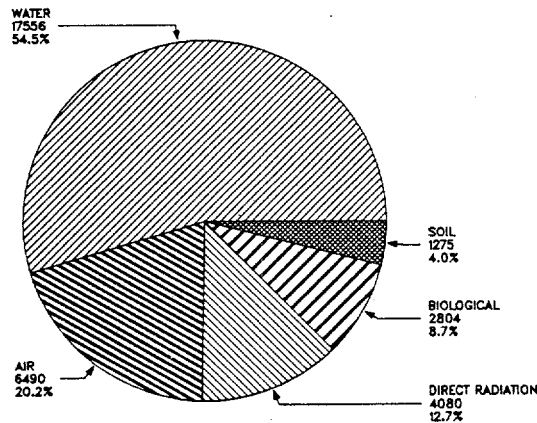


Fig. 4.11. Total number of samples collected.

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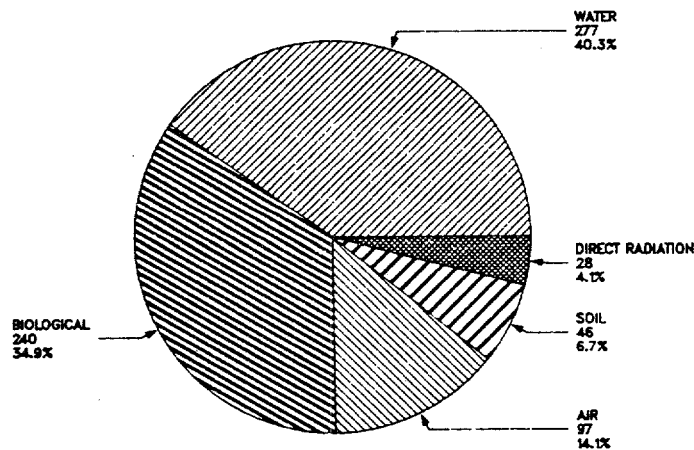


Fig. 4.12. Total number of sampling stations.

The Environmental Surveillance Group has joint responsibility with the Data and Instrumentation Group to develop sampling and monitoring programs that meet the goals of the DEM. This includes the development of sampling plans, following the EPA, DOE, and UCC-ND methods and procedures.

The 1983 year was a period in which routine sampling requirements were expanded, but beyond that it was a year for several special sampling, monitoring, and supporting functions:

- Assisted the Environmental Sciences Division with the vehicle-killed deer pickup and autopsy program.
- Implemented a TLD program on East Fork Poplar Creek.
- Conducted a wastewater characterization program of the discharge of ORNL facilities at Y-12.
- Assisted the DOE in emergency response capabilities by participating in the Nuclear Weapons Accident Exercise conducted at the Nevada Test Site, the 1983 TVA Sequoyah Nuclear Power Station Emergency Exercise, and the 1983 Commonwealth of Virginia Surry Nuclear Power Plant Emergency Exercise.
- Provided support for the subcontract with Virginia Polytechnic Institute and State University for the study of aquatic insects from White Oak Lake.
- Provided support for the subcontract with The University of Tennessee to conduct velocity evaluations for six ORNL stacks.
- Conducted a special sampling program on White Oak Creek and White Oak Lake to determine mercury contamination in sediments.
- Assisted with the ORNL/DOE response to the Compliance Evaluation Inspection of the Oak Ridge National Laboratory by the state of Tennessee and the EPA.
- Provided special sampling of the Sewage Treatment Plant and White Oak Creek during a period of operational problems.
- Conducted a special survey of the ORNL Sewage Treatment Plant system, White Oak Creek, White Oak Lake, and the Clinch River for the release of ^{131}I and ^{99}Tc .
- Conducted a special sampling of HFIR ponds, Melton Branch, and White Oak Lake for the release of ^{24}Na from the HFIR facility.
- Assisted with the start-up of the new weirs and monitoring stations at Melton Branch, White Oak Creek, and White Oak Dam.
- Conducted the sampling of the Oak Ridge City Sewage Treatment Plant for the 129 priority pollutants.
- Began the collection of samples from the new PAM stations at Y-12 and the American Museum of Science and Energy.
- Placed new water samplers at Building 1505 and the Sewage Treatment Plant.
- Conducted a special sampling of Lamberry Quarry.
- Collected soil samples from around Buildings 4501, 3592, and 3503 for mercury analysis.
- Collected drinking well water samples from off-site locations for radionuclide analysis.
- Initiated a major sampling effort for the surplus facilities management program with the goal of providing information on the radiological and nonradiological conditions of selected sites for planning of decontamination and decommissioning activities.

The Environmental Surveillance Group also provides monitoring and sampling activities for the Oak Ridge Gaseous Diffusion Plant (K-25), Y-12, and the Paducah Gaseous Diffusion Plant (PGDP). These programs include:

- Stack sampling program for Y-12.
- Soil and vegetation samples for Y-12.
- TLDs for PGDP and K-25.
- Wildlife and vegetation samples for PGDP.
- Data from PAM stations, fish and water samples from the Clinch River, and other types of samples primarily collected for ORNL which are provided to Y-12 and K-25 for their use.

4.9.4 Hazardous Materials Control Group

The Hazardous Materials Control (HMC) Group is primarily responsible for managing hazardous materials and waste activities for ORNL and its facilities at the Y-12 site. Hazardous materials are controlled from their initial purchase or generation, during their use and storage, and during their treatment or disposal. This responsibility must be met in order for the Laboratory to comply with pertinent federal and state laws and regulations, DOE orders, corporate standard practice procedures, and Laboratory policies.

During 1983, approximately 480 waste disposal requests were handled by the HMC Group (Fig. 4.13). These requests represented over 140,800 kg of hazardous waste materials generated by the

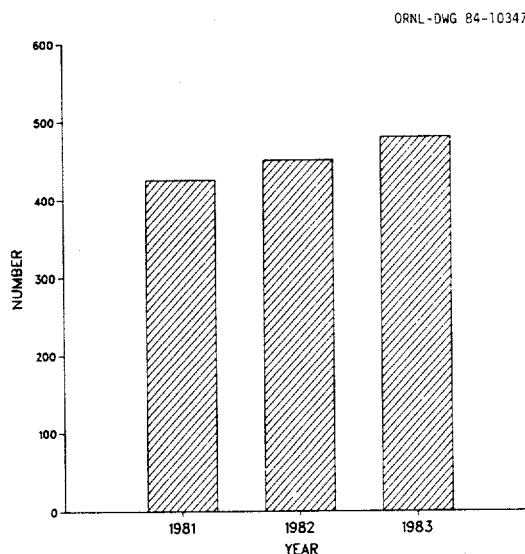


Fig. 4.13. Disposal requests processed by the Hazardous Materials Control Group.

ORNL facilities (Fig. 4.14). A large majority of these materials is shipped to off-site commercial facilities for treatment or disposal. However, some waste streams are being managed by on-site operations (i.e., recovery of silver from photo reproduction wastes, recycle of noncontaminated oils, recycle of waste mercury, detonation of explosive chemical wastes, and chemical reaction of water reactive chemical wastes). Figure 4.15 represents a percentage breakdown of the types of hazardous waste materials. Of the total generated, over 60% must be stored or disposed of via landfilling, incineration, or other controlled methods.

Recycle/Recovery Operations

The silver recovery system, which began operations in 1982, processed over 16,600 L of silver-containing wastes during 1983. This represents approximately 600 troy ounces of silver metal which was recovered and returned to DOE's precious metal pool.

Noncontaminated waste oils generated by various Laboratory processes represented a total of 37,830 L of waste material which was recycled.

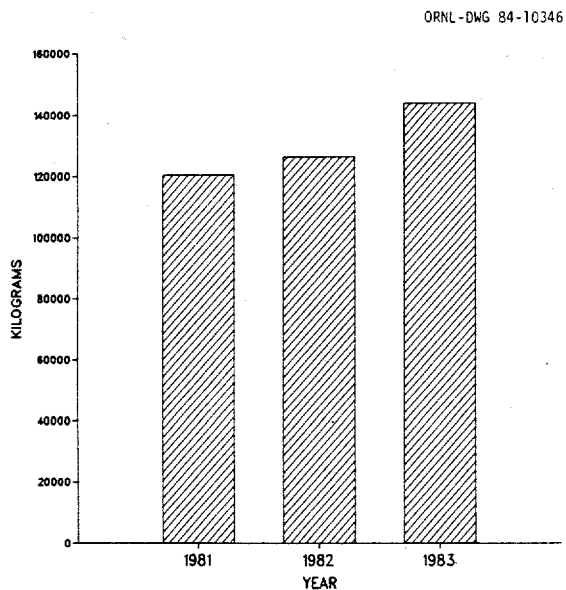


Fig. 4.14. Hazardous waste totals.

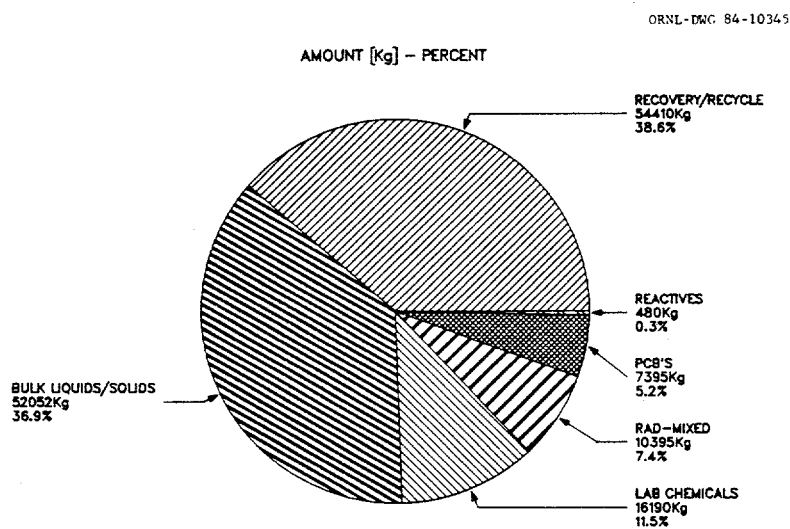


Fig. 4.15. Percentage breakdown of types of hazardous waste.

Hazardous Waste Management Data Systems

Several computerized data systems were used by the HMC Group during 1983 in a continuing effort to provide accurate information on waste management activities. The Hazardous Materials Tracking System (HMTS) will track all hazardous materials as they make their way through the Laboratory once the full system is on line. At present, only the waste disposal files are in use; however, it is hoped that we will be able to initiate the barcode labeling phase of the system during 1984.

The PCB tracking system was created to maintain accurate files on all equipment containing PCBs in use at the Laboratory, dates the equipment was drained and removed from service, PCB

concentration, dates PCB wastes were placed in storage, and when shipped for disposal, etc. This information is important for ensuring Laboratory compliance with the Toxic Substances Control Act (TSCA) and the regulations governing PCBs (i.e., 40 CFR Pt. 761).

The Asbestos Waste Disposal System has continued to be effectively used. In 1983, ORNL disposed of over 1400 m² of asbestos insulation from pipelines and over 240 m² of asbestos insulation from tanks and ductwork. Also during 1983, a major program was undertaken by this Department and the ORNL Industrial Hygiene Department to identify areas, both indoors and out, where asbestos insulation could pose potential hazards to personnel and/or the environment. Approximately 50 such areas were identified. The insulation was removed and replaced with nonasbestos material. This identification process is expected to continue over the next few years.

RCRA Permit Application

During 1983 a considerable amount of personnel time was spent in the preparation of the RCRA Part A and B permits for the new Hazardous Waste Storage Facility at ORNL. Many issues and questions had to be resolved, and the question of the facility operator has prevented the EPA from issuing the permit.

Disposal of Reactive/Explosive Chemical Wastes

With the addition of an experienced handling expert to the group, HMC personnel were able to dispose of a five-year backlog of explosive chemical wastes. Through the use of commercially available plastic explosives, ~75 kg of these waste materials were detonated per requirements outlined in 40 CFR Pt. 265.382.

The group has also provided assistance to the Department and the Division in several other areas:

- Provided support for subcontract with the University of Tennessee to study volume reduction options on low-level radioactive wastes generated at the Biology Division.
- Provided assistance to the sampling group's soil sampling program for mercury around Buildings 3503, 3592, and 4501.
- Made updates and revisions to ORNL's Spill Prevention Control Countermeasures and Contingency Plans.
- Established in-house RCRA training programs for Department and support personnel in the area of hazardous waste management activities. An individual within the group was assigned the responsibility of RCRA Training Coordinator.
- Prepared the Hazardous and Radioactive Mixed Waste Management Plan for ORNL as required by DOE Order 5480.2.

5. SAFETY DEPARTMENT

M. W. Knazovich

J. F. Alexander	M. F. Fair
J. S. Brown	L. L. Huey
G. H. Burger	H. M. Lockhart
B. F. Burns	J. D. Miller
D. T. Dice	R. E. Millsbaugh
K. H. Poteet	

5.1 INDUSTRIAL SAFETY

The Industrial Safety Section is responsible for developing and implementing accident prevention and loss management programs within the Laboratory. The staff provides consultation and assistance in matters concerning industrial safety and participates in inspection and evaluation programs to assess the level of safety in various ORNL activities. The staff participates in a variety of safety-related activities, including developing safety policies and procedures, reviewing engineering drawings for safety content, and providing safety orientation and specialized safety education programs. The group maintains a library of DOE-prescribed safety standards, safety reference material, and audiovisual aids. The section provides Laboratory-wide on- and off-the-job safety promotion activities. Whenever an injury or accidental property loss occurs, the safety staff is involved in the investigation, analysis, classification, and documentation of the incident. The safety staff also provides support to ORNL's Construction Engineering Section in carrying out the construction safety program.

The Industrial Safety Section assists management in formulating and directing the Laboratory's safety program and in developing and maintaining a high level of safety awareness in all Laboratory employees through a program consistent with corporate safety policies.

5.1.1 Industrial Safety Activities

The safety staff assists the management line organization and Laboratory personnel in all areas relating to personnel safety and accident prevention. A principal function is to help Laboratory division representatives in the development of action plans to meet safety requirements adequately. Included in the action plans are the routine activities normally associated with a successful safety program: (1) conducting safety meetings and inspections; (2) investigating, analyzing, and reporting all accidents and near misses; (3) formulating and issuing policies, guides, procedures, and standards; (4) providing education and training services; (5) conducting periodic safety performance appraisals; (6) seeking to improve off-the-job safety performance; and (7) preparing records and reports. The staff performs quarterly evaluations of each Laboratory division's safety performance in these and other areas. Safety action plans for all Laboratory divisions were developed in 1983.

The section was audited in February 1983 by representatives of the UCC-ND Office of Health, Safety, and Environmental Affairs. The UCC-ND Safety and Health Audit recognized ORNL for administering effective and innovative safety and health programs consistent with UCC, DOE, UCC-ND, and Laboratory requirements but noted several procedural errors for which corrective action was immediately initiated.

5.1.2 Construction Safety

Special emphasis on construction safety continued during 1983. Several safety training sessions were held with ORNL construction engineers to help them better recognize safety problems on the worksite; these sessions dealt with such subjects as protective equipment, falling hazards, safety awareness, and steel construction.

Formal, documented site inspections with the construction engineers were supplemented by informal site visits. Prompt corrective action was emphasized when deficiencies were noted. Participation in preconstruction meetings and review of engineering designs and specifications were also part of the construction safety effort.

5.1.3 Off-the-Job Safety

An ORNL off-the-job safety action plan was developed to formalize efforts under way to reduce off-the-job injuries that result in pain suffering to employees and a large economic loss to the Laboratory. Off-the-job safety was emphasized through safety bulletins, quarterly safety meetings, new visual aids, and promotional literature. The National Safety Council's (NSC) quarterly publication *Family Safety Magazine* was mailed to the home of each ORNL employee. Off-the-job safety will continue to receive strong emphasis as part of the Laboratory's overall safety program.

5.1.4 Safety Performance

The continuing emphasis on safety in 1983 resulted in significant improvements in the ORNL safety program. Through the combined efforts of all employees, ORNL safety performance was excellent.

	Lost workday cases		Recordable injuries and illnesses	
	Number	Incidence rate	Number	Incidence rate
1983 (actual)	2	0.05	25	0.64
1983 (control)	1	0.02	32	0.76

As of December 31, 1983, the Laboratory had worked 157 days and accumulated 3,339,681 exposure hours since the last lost workday case.

The off-the-job safety program was expanded in 1983 by devoting more safety meetings to the subject. In these meetings, films purchased from outside sources, internally created videotapes, and talks about personal experiences were presented. Additionally, information on off-the-job accident prevention continued to be distributed to employees as handouts in safety meetings and through direct mailing to employees' homes. ORNL safety performance in this area left much to be desired:

	Off-the-job disabling injuries	Off-the-job frequency rate
1983 (actual)	62	3.80
1983 (control)	47	2.79

A comparison of UCC-ND on-the-job lost workday and recordable injury and illnesses cases is shown in Tables 5.1 and 5.2, respectively.

The laboratory earned the following awards for safety performance in 1983:

- The NSC Award of Honor for the ninth consecutive year (NSC's highest award)
- The DOE Award of Excellence for maintaining the incidence rate of lost workdays and restricted work cases below 1.1 for five consecutive years

Continued outstanding safety performance contributed to a reduced Workmen's Compensation premium paid by ORNL—over \$1,300,000 (based upon the 1979 premium rate) saved in the past three years.

Employees throughout the Laboratory demonstrated a very positive attitude toward safety, and with this type of continued attitude and effort, ORNL will stay well below our control limits for 1984.

Table 5.1. UCC-ND comparison of on-the-job lost workday cases and incidence rates

Site	1979		1980		1981		1982		1983	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
ORNL	3	0.07	3	0.07	0	0.00	1	0.02	2	0.05
Y-12	2	0.03	1	0.02	2	0.03	2	0.03	4	0.06
ORGDP	0	0.00	2	0.04	1	0.02	1	0.02	2	0.05
PGDP	1	0.05	2	0.11	0	0.00	0	0.00	0	0.00

Table 5.2. UCC-ND comparison of recordable injuries and illnesses and incidence rates

Site	1979		1980		1981		1982		1983	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
ORNL	44	1.05	41	0.96	41	0.95	24	0.59	25	0.64
Y-12	56	0.91	80	1.25	53	0.86	66	0.96	76	1.10
ORGDP	72	1.25	55	0.98	49	0.96	25	0.59	24	0.61
PGDP	36	1.75	25	1.34	19	1.19	18	1.38	12	0.98

5.1.5 Education and Training

The Department provided on-the-job training for a graduate student from the University of Tennessee that was the equivalent of a one-quarter course in the graduate safety program at the university.

5.2 OFFICE OF OPERATIONAL SAFETY

In 1983 the Office of Operational Safety (OOS) continued to discharge its safety responsibilities to the Laboratory by coordinating and managing an effective operational safety program to ensure that all reactors and nonreactor nuclear facilities continued operation in a safe and responsible manner in accordance with Laboratory and DOE requirements.

Achievement of an effective operational safety program requires participation and support from many individuals and groups, beginning with line operators, and visible support from all levels of management. To provide the expertise to determine and ensure that all facilities are safely operated, the Laboratory Director's Review Committees were used extensively, as were the services of Laboratory divisions' radiation control officers (RCOs) and division safety officers (DSOs).

To provide the means to manage the Operational Safety Program effectively, the total effort is divided into several functional groups and responsibilities: the Laboratory Director's Review Committees; DSO-RCO activities; staff consultation and review activities; the ORNL Safety Analysis and Review Program; decontamination and decommissioning activities; and the Unusual Occurrence Reporting (UOR) System.

These responsibilities and functions are managed and coordinated by the OOS staff, which consisted of the office director, two technical staff members, and a secretary in 1983. The technical functions and responsibilities were divided between the director and staff. Secretarial and administrative functions such as arranging and scheduling committee meetings, preparing committee reports, memoranda and other correspondence were the responsibility of the secretary. Because of the increased work resulting from increased DOE requirements in audits, training, and documentation, and additional responsibilities assigned to the OOS, plans are under way to increase both the technical and secretarial staff in 1984.

5.2.1 Laboratory Director's Review Committees

The Laboratory Director's Review Committees were again very active in 1983, performing both periodic and specially called reviews and audits of facilities and operations in their respective areas of responsibility. The OOS again coordinated activities of the committees: Radioactive Operations, Reactor Operations Review, Reactor Experiments Review, High-Pressure Equipment Review, Transportation, Accelerators and Radiation Sources Review, Criticality, and Electrical Safety.

In 1983 the committees conducted 49 periodic reviews and 16 special reviews. There were three meetings with the Laboratory Executive Director to discuss committee recommendations and concerns resulting from the year's activities. Executive Director meetings with the remainder of the committees will continue into next year.

The OOS serves as the representative of Laboratory management in ensuring implementation of committee recommendations and in resolving any disputes which may result from them. Considerable time was spent in follow-up of these recommendations.

5.2.2 DSO-RCO Activities

The DSOs and RCOs continued to play a very important role in the Laboratory's overall safety program in 1983. Several divisions made changes in DSO-RCO assignments during the year, and they are reflected in the listing of current assignments in Table 5.3.

Table 5.3. Division safety officer-radiation control
officer directory, July 15, 1983

Division	Name	Phone	Bldg.	Room	MS
Analytical Chemistry	R. E. Jones, RCO	4-4886	2026		
	A. L. Harrod, DSO	4-4853	4500S	S-150	148
Biology	J. A. Otten, DSO, RCO	4-1198	9207	A-403	007
Chemical Technology	C. D. Watson, DSO, RCO	4-6140	4500N	B-232	01A
	F. A. Kappelmann, Alt.	4-6569	3508	A-002	
Chemistry	F. J. Smith, DSO	4-4945	4500S	F-260	254
	L. L. Brown, Alt. DSO	4-5034	4500N		
	D. R. Simpson, RCO	4-4996	5505		
	W. D. Carden, Alt. RCO	4-4997	5505	026	
Computer Sciences	J. M. Barnes, DSO, RCO	4-6087	6025		
Central Management	G. C. Cain, DSO	4-6606	5000		
Employee Relations	J. A. Holloway, Jr., DSO	4-4438	4500N	J-104	108
Energy	C. M. Haaland, DSO, RCO	4-4518	3001	304	217
Engineering	A. D. Johnson, DSO	4-6450	1000	103B	107
Engineering Technology	C. A. Mills, DSO	4-0410	9201-3		002
	R. B. Gallaher, Assoc. DSO	4-0385	9764		001
	A. W. Longest, RCO	4-0259	9201-3	399	005
Engineering Physics & ORELA	R. R. Spencer, DSO, RCO	4-6126	6010	203	207
	S. L. Rider, Alt.	5-7156	6025		
Environmental Sciences	M. H. Shanks, DSO, RCO	6-2372	1505	156	
Finance and Materials	G. E. Testerman, DSO	4-6075	4500N	J-224	221
Fuel Recycle	D. E. Dunning, DSO, RCO	4-7140	7601	204	
Fusion Energy	W. C. Brock, Jr., DSO, RCO	4-0139	9201-2		007
	G. F. Bowles, Alt.	6-3711	9201-2		007
Health Division	J. A. Ealy, DSO, RCO	4-6167	3550	016	
	W. E. Porter, Alt.	4-6164	3550	015	
Health & Safety Research	F. R. O'Donnell, DSO, RCO	6-2132	4500S	E-216	
Industrial Safety & Applied Health Physics	R. E. Millsbaugh, DSO	4-6680	4500S	H-260	
	A. J. Smith, RCO	4-6524	3001		
Information	E. J. Howard, Sr., DSO	4-0668	9711-1		
	J. G. Pruett, DSO	6-1750	2024		
Instrumentation & Controls	E. M. Robinson, DSO, RCO	4-6681	3500	12	
Laboratory Protection	R. L. Atchley, DSO	4-6277	2500	105	112
	H. C. Austin, RCO	4-7017	3037	203	205
Metals & Ceramics	W. H. Miller, Jr., DSO, RCO	4-5171	4508		
	E. S. Bomar, Assoc. RCO	4-5125	4508		
Operations	D. W. Ramey, DSO, RCO	4-5912	2024	54	
Physics	K. S. Toth, DSO, RCO	4-4732	6000	257	255
Plant & Equipment	R. H. Winget, RCO, DSO	4-4303	2518	201	207
Quality Assurance & Inspection	J. L. Holbrook, DSO, RCO	4-7247	2000	8	
	R. G. Pope, Alt.	4-7282	2000	39	
Solid State	R. R. Coltman, DSO	4-6263	3115	002	
	H. R. Child, RCO	4-5235	3025	E-209	

During 1983 quarterly meetings were conducted on January 27, April 27, July 26, and October 20. The Laboratory Executive Director was present at the January 27 meeting and kicked off the year's activities. These meetings are documented in ORNL/CF-83/19, ORNL/CF-83/99, ORNL/CF-83/257, and ORNL/CF-83/325, respectively.

5.2.3 ORNL Safety Analysis and Review Program

Work on the Safety Analysis and Review Program for Nonreactor Nuclear Facilities required by DOE Orders 5481.1A and OR 5481.1A continued in 1983. To speed up the completion of documentation of existing nonreactor nuclear facilities, five retired Laboratory employees were engaged as consultants to begin writing safety analysis reports (SARs) for five facilities. All consultants were experienced technical operating or engineering personnel, very familiar with the actual facility or type of facility that they were engaged to write about. During the year, writing of other safety documentation by current facility operators continued, as did writing of documents for new or major modified facilities by Engineering Division and/or specially assigned operating groups.

At the end of 1983, seven SARs and Operational Safety Requirements (OSRs) for existing facilities and five for new facilities had been completed and received DOE/ORO approval. Drafts of nine SARs and OSRs for other existing facilities were completed by the end of the year, and writing of SARs by the consultants was begun during the year on five other existing facilities. The writing of the SAR and OSR for one new project, the Consolidated Edison Uranium Solidification Project (CEUSP), was also completed in draft form in 1983. Therefore, at the end of 1983, SARs and OSRs for 21 out of the Laboratory's 24 existing nonreactor nuclear facilities (excluding accelerators) had either been written and approved by DOE, had been completed in draft form, or were being written. The total documented cost to date of the safety documentation program for existing facilities is \$1,200,000.

By the end of FY 84, it is expected that safety documentation for all but 4 of the 24 nuclear facilities (excluding accelerators) will have been submitted to DOE/ORO. Documentation for the others started by consultants in FY 84 will be completed in FY 85, as will draft documents for all the Laboratory's accelerators. The entire Safety Documentation Program for Nonreactor Nuclear Facilities is expected to be complete by the end of FY 86.

5.2.4 Facility Decontamination and Decommissioning (D&D)

A considerable effort is under way in the Laboratory to decontaminate and decommission surplus nuclear facilities. This effort is directed by the Surplus Facilities Management Program within the Laboratory's Waste Management Program with input from several divisions and safety and environmental groups. A member of the OOS staff is assigned to represent Operational Safety interests and coordinate health physics concerns in the D&D effort. Considerable work was done by the assigned staff member during 1983 in reviewing D&D criteria, assisting in planning of D&D activities, and helping to establish health physics and radiological characterization requirements for surplus facilities scheduled for D&D.

In addition to reviews, specific D&D activities during the year involving staff participation included beginning work in Buildings 3505 and 3517, completion of emptying the gunite waste tanks, and removal of old ducts and other equipment during renovation of the 3039 stack ventilation system.

An OOS staff member served on the Surplus Facilities Management Program's Ad Hoc Review Committee, which considered long-range plans for surplus facilities and recommended decommissioning options.

5.2.5 Unusual Occurrence Reporting (UOR) System

One staff member is assigned the responsibility for coordinating the Laboratory's UOR system. Considerable time was required to process the 24 UORs generated in 1983 that resulted from occurrences in 6 divisions (of the 21 in the Operations Division, 15 resulted from reactor operating problems).

In addition to ensuring that UORs are written when required, the UOR Coordinator follows the proposed corrective action listed in the report, ensures that final UORs are prepared, and writes quarterly summaries for distribution to ORNL, division, and DOE management.

5.2.6 Staff Consultation, Review, and Other Activities

Again in 1983, a large portion of staff time was required to manage Operational Safety concerns and activities in addition to those previously discussed. The staff reviewed numerous proposed experiments and operations and/or changes to them and processed requests for approval for their operation. The types of activities reviewed and/or approved included changes in reactor controls and instrumentation, disposal of radioactive wastes, transportation of nuclear and other hazardous wastes, design and operation of high-pressure experiments and reactor experiments, facility design criteria and operations, and changes and proposals involving handling and processing of radioactive materials.

Additional staff activities included participation in and/or conducting investigation of operational incidents and minor radiation incidents. Assistance was also provided in planning and observing emergency drills; e.g., considerable effort went into planning, assisting, and observing a criticality accident drill held in October. The staff also participates in and develops procedures for the *ORNL Health Physics Manual*, *ORNL Safety Manual*, and *Standard Practice Procedures*. Considerable staff time was spent in 1983 in reviewing and revising procedures in these manuals.

Assistance to Engineering Division in developing the criteria for polycarbonate glove box windows continued. These criteria will be included in a revision of *Criteria for Controlled Atmosphere Chambers* (ORNL/TM-6865). Assistance was also provided to Laboratory staff members in the design, procurement, and use of glove boxes.

As part of the responsibility of providing liaison between ORNL management and the DOE on operational safety matters, several meetings were held with DOE safety staff personnel. Included in these meetings was participation in the following surveys, reviews, and audits:

- DOE 1983 Reactor Safety Appraisal, November 14-22, 1983
- DOE 1983 Criticality and Transportation Safety Audit, September 6-9, 1983
- DOE 1983 Health Physics Audit, September 19-October 28, 1983
- DOE 1983 Fire Protection Appraisal, July 18-28, 1983
- DOE Nonreactor Nuclear Facility Safety Appraisal, June 27-August 19, 1983

Staff members of the OOS assisted Laboratory divisions in developing training programs for operators and supervisors of nonreactor nuclear facilities. The training programs are required by DOE Order 5480.1A, Chapter V, and DOE Order 5481.1A.

Office responsibility in these audits also includes following up audit recommendations and generating progress reports when necessary. The staff also participated in the Nuclear Division's audit of the Laboratory's Safety Program and Safety Analysis Documentation Program. The Office Director also served as a member of the UCC-ND audit team reviewing the Safety Analysis and Review Program of the Y-12 Plant. Another staff member served on the UCC-ND audit team reviewing the health physics program and related activities at the PGDP.

5.2.7 Summary

There were no facility or nuclear reactor accidents or incidents that resulted in personal injury or were reportable to DOE in 1983. There were, however, minor operating incidents which resulted in UORs or quality assurance deficiency reports.

Consultation, review, and approval of numerous requests and concerns involving operational safety matters presented by Laboratory facility staffs were handled by the OOS staff in 1983. The staff continued to review (or organize review of) facilities by the appropriate Director's Committees to ensure continued safe operation and to bring matters of concern to management's attention.

Staff work increased in managing and executing the Laboratory's safety documentation program because of the acceleration of document preparation by employing consultants to prepare SARs. The workload was also increased because of participation in a extensive review of the Laboratory's safety analysis program by DOE/ORO over the period from June 27 to August 19. In addition, extensive work was done in providing assistance and reviewing preparation of the SARs for CEUSP and the Building 3039 stack ventilation system.

Work continued in assisting the ORNL waste management group in planning, reviewing, and executing D&D activities. Special attention was given to the D&D work started in Building 3505 and that ongoing in renovation of the Building 3039 stack ventilation system.

Coordination of the Laboratory's UOR program continued during the year and required considerable attention to ensure that timely reports were written and distributed in a responsible manner and to see that follow-up actions were implemented.

The staff workload has steadily increased during the past several years, and 1983 was no exception. Because of increased assigned duties and more DOE requirements in audits, training, and documentation, responsible handling of all operational safety concerns by the present staff became very difficult during the year. To overcome this problem, plans for increasing the staff, both technical and administrative, are under way. The replacement for a retiring technical staff member was approved, and the request for one additional technical and one additional administrative staff member is under consideration.

6. RADIATION AND SAFETY SURVEYS DEPARTMENT

H. M. Butler

J. F. Allred	J. L. Gray	R. D. Parten
B. C. Burrell	C. R. Guinn	G. R. Patterson
A. C. Butler	S. A. Hamley	J. H. Pemberton
B. A. Campbell	C. E. Haynes	B. A. Powers
W. D. Carden	C. F. Jackson	J. C. Richter
A. Cardwell	R. L. Jeffers	K. C. Scott
T. G. Clark	L. C. Johnson	D. R. Simpson
R. E. Coleman	R. D. Kennedy	J. R. Slaten
M. L. Conner	R. E. Keny	A. J. Smith
R. C. Cooper	J. D. Long	C. F. Smith
P. E. Cox	R. B. Malcolm	L. L. Sowell
J. C. Davis	W. T. Martin	J. H. Spence
M. R. Dunsmore	W. A. McLoud	L. E. Thompson
A. B. Eldridge	C. H. Miller	R. L. Walker
R. H. Enix	D. G. Noe	K. M. Wallace
W. F. Fox	L. C. Odom	B. A. Wieman
I. H. Wiggins	C. F. Zamzow	

6.1 FACILITIES' OPERATIONS MONITORING

The Radiation and Safety Surveys (R&SS) Department provided radiation and safety surveillance services at facilities operated by research and operating groups to keep exposures to personnel, concentrations of airborne radioactivity, and levels of surface contamination well within permissible limits and in agreement with the as-low-as-reasonably-achievable (ALARA) philosophy. These surveillance responsibilities were performed by R&SS Department staff working in nine geographical areas referred to as Complexes. Figure 6.1 shows the boundaries and the name of the area leader of each Complex. Each area contains a mix of R&SS Department staff that is dictated by the type and magnitude of hazard that exists.

Support and assistance in coping with the problem associated with radiation work, other than surveillance, was provided through seminars, safety meetings, and discussion with those planning, supervising, and performing the work. The vast majority of our ORNL operations proceed without incident; however, during 1983 there were 17 minor incidents, all of which were well below the level requiring an official report to DOE. The following is a brief review of some of the major nonroutine activities involving R&SS staff.

Bulk Shielding Reactor (BSR), Building 3010

In 1983, the BSR was shut down for pool maintenance. All old experimental assemblies and other used equipment were removed from the pool and sent to the burial ground or to storage. Fuel elements

The map shows the Coleman area with streets including Coleman Blvd, 7500 Area, 7600 Area, 7700 Area, and 7800 Area. A legend indicates that buildings with a star symbol are 'MILITARY' and buildings with a square symbol are 'CIVILIAN'. A scale bar at the bottom shows a distance of 1 mile. A north arrow is located in the upper right corner.



Fig. 6.1. Geographical boundaries of radiation and safety surveys area complexes.

from the BSR and Pool Critical Assembly were transferred to the Building 3001 canal and the ORR pool for storage. The pool water was drained and the walls and floors were repaired and repainted. This work took place from January through October 1983. An examination of exposure sustained by those involved in this operation indicated that close surveillance by R&SS staff resulted in minimal exposures.

Radiochemical Pilot Plant Operations, Building 3019

Plutonium Uranium Microsphere Preparation (PUMP). PUMP facilities began operations in February 1983. During the year, several kilograms of plutonium were processed in this facility to produce mixed-oxide microspheres of plutonium and depleted uranium. Microspheres meeting specifications are packaged and shipped off site for fuel pellet fabrication and irradiation testing in the Fast Flux Test Facility (FFTF). R&SS Department personnel provided health physics training for PUMP technical support personnel and maintained close surveillance of PUMP operations and facilities. In general, radioactive material containment was good, though there were two minor releases in one of the PUMP laboratories. Dose equivalents sustained by individuals involved in this process were well below permissible levels.

Consolidated Edison Uranium Solidification Program (CEUSP). Approximately 1050 kg of uranium recovered from the Consolidated Edison Indian Point Reactor is stored as uranyl nitrate in the Thorium Reactor Storage Tank (TRUST). To eliminate some concerns about the safety of the present storage, the uranium is to be solidified and stored in sealed cans in a vertical array previously installed in Cell 4. The cost plus award fee (CPAF) contractor continued installation of equipment for this process in Cell 3 and adjacent facilities. The R&SS Department staff provided health physics indoctrination, consultation, and monitoring surveillance for contractor personnel, who cooperated in maintaining Cell 3 essentially free of transferable contamination so that C-Zone clothing was not normally required.

Air filter samples were collected regularly from the duct that vents the TRUST pit to Cell 5. Evaluation of these samples indicated no leakage of uranium from the storage tank.

The R&SS Department staff also recommended shielding requirements for CEUSP sample transfers and provided input for the CEUSP Final Safety Analysis Report and Operating Safety Requirements documents.

^{233}U Processing and Storage. The Radiochemical Pilot Plant serves as a repository and processing center for the Department of Energy's inventory of ^{233}U . Safeguarded storage for ^{233}U solids and liquids is provided. Process facilities are maintained in operational readiness for dissolution of ^{233}U solids, for solvent extraction and ion exchange purification of ^{233}U nitrate solutions, and for conversion of these ^{233}U nitrate solutions to oxides.

During the year, approximately 55 kg of ^{233}U was received and placed in storage. One oxide conversion run and several dissolution and purification runs were made. The R&SS Department staff provided health physics consultation, training, and monitoring surveillance for operation, maintenance, and modifications to these facilities. Eighty-three Radiation Work Permits were certified for jobs involving a potential for exposure beyond the daily permissible limits. Radiochemical Pilot Plant personnel cooperated in minimizing personnel dose equivalents and in confining loose radioactive materials to established zones where control measures were adequate.

Isotope Area Operations, Building 3038

Work in this area involved the production, packaging, and shipment of radioisotopes for medical, industrial, and experimental uses. Principal isotopes were ^3H , ^{85}Kr , ^{60}Co , ^{75}Se , ^{90}Sr , ^{90}Y , ^{153}Gd , ^{137}Cs , ^{192}Ir , ^{237}Np , ^{241}Am , ^{244}Cm , ^{252}Cf , and several isotopes of plutonium. A total of 2421 radioactive shipments were made during the year. The Isotope Research Materials Laboratory continued the fabrication of flux monitors from various isotopes of Np, Pu, Th, and U. This group also prepares 20- and 50-cm-diam ^3H targets for shipment to Lawrence Livermore National Laboratory and Japan; monitoring all shipments ensured that they were in compliance with applicable U.S. Department of Transportation regulations.

Decontamination of the curium cells in Building 3038 and the charging area east of the cells was completed and the cells made ready for other operations. Extremely high levels of alpha contamination, with smears counting greater than 1.0×10^6 alpha disintegrations per minute required close monitoring to prevent uncontrolled spread of contamination.

The Radioisotope Development Group handled approximately 120,000 Ci of ^3H in the fabrication of light sources that are being used primarily for runway markers at airports. The potential uses of such devices are numerous, e.g., highway markers and signs at construction sites.

Cell Ventilation Duct Removal, Building 3039 Stack

During the first quarter of 1983, R&SS personnel monitored the dismantling and removal of the cell ventilation ducts from the 3039 stack area by the Rust Engineering Co. Each section of duct was wrapped in plastic as it was dismantled and transferred to the Solid Waste Disposal Facilities for disposal. Radiation levels encountered during the dismantling operation were as high as 3 mGy/h (300 mrad/h). Aggravating the problems introduced by the presence of radiation and contamination was the deteriorated condition of the ducts and severe weather conditions that sometimes threatened the plastic enclosures. Good planning and cooperation with Rust Engineering personnel, cautious execution, and continuous monitoring by R&SS personnel kept exposures well below permissible levels and prevented any significant spread of contamination.

Oak Ridge Research Reactor (ORR), Building 3042

One program of interest at the ORR was the visual and ultrasonic inspections and subsequent modification and repair of the ORR reactor primary coolant lines. Small holes in both lines required the installation of mechanical patches to prevent further water leakage to the ground. Removable spool sections in both the inlet and exit lines and another strainer in the reactor vessel inlet line were installed. Radiation readings in both lines varied; up to a maximum of 2.5 mGy/h (250 mrad/h) were observed. Although the beta-gamma contamination levels were high, activity was confined to the established contamination zones through deployment of good radiation hygiene practices by those involved in the work and close monitoring by health physics personnel.

Another item of concern was the failure in November of the TRIGA-LEU experiment in the F-9 position of the reactor core that resulted in both the primary and pool systems becoming grossly contaminated with mixed fission products. Radiation readings observed on the outer surfaces of the primary lines varied from 3 mGy/h (300 mrad/h) to 30 Gy/h (3 rad/h). Readings taken in the east reactor pool ranged from 2.5 mGy/h (250 mrad/h) to 5 mGy/h (500 mrad/h). Beta-gamma transferable activity in both systems indicated that the walls and equipment were contaminated up to 2 mGy/h (200 mrad/h) and a maximum alpha count of 1.5×10^4 disintegrations/min \cdot 100 cm².

To minimize the hazards associated with the day-to-day operation of the facility, several precautionary steps (including increased health physics consultation, surveillance, and monitoring support) were implemented by the EOS Division.

Manipulator Repair Shop Operations, Building 3074

The Plant and Equipment (P&E) Division operates this facility for repair and maintenance of manipulators and other specialized hot cell equipment. Vacuum pumps are also serviced. Manipulators, parts, etc., are often grossly contaminated with alpha and/or beta-gamma emitters and must be decontaminated in specially designed glove boxes. R&SS Department personnel perform detailed surveys of manipulators, parts, and associated equipment at various stages of decontamination and repair and advise maintenance personnel on procedures to be followed. Radiation control in this facility has been very good.

Decontamination and Decommissioning of Cell 8, Building 3517

Decontamination and decommissioning of Cell 8, Building 3517, was started on August 2, 1983. Cell 8, one of the shutdown process cells used in the processing of ^{137}Cs during the 1960s and 1970s, is a stainless-steel-lined cell 7.5 ft wide by 12.5 ft long and 12 ft deep. It contained one 25-gal and two 125-gal stainless steel tanks, and a great deal of piping to other tanks within the system, service piping, and instrumentation lines. The decommissioning was performed from the top of the cell by P&E personnel using remote cutting tools. Personnel worked in a background of 3 mGy/h (approximately 300 mrad/h) at the top of the cell. Readings on tanks and valves in the cell went to 1 Gy/h (100 rad/h) at 15 in. About 50 entries were made by P&E personnel to assist the Operations Division in dismantling this equipment.

Some 9.4 m³ of solid waste was removed from the cell and sent to the Solid Waste Storage Area; about 45 m³ went to the compactible dumpster prior to disposal as compacted waste. Approximately two months were required to complete the work, with almost continuous surveillance provided by R&SS personnel. About 70 P&E personnel were used on the job so that exposures on this job would not exceed 10% of the annual limit. External exposure levels remained within the limit and contamination was confined to the immediate area surrounding the cell entrance.

Wings 1, 2, & 3, Building 4500N

This area contains facilities occupied by several divisions and as a result research is diverse. Chemical Technology uses various types of bacteria to reduce wastes, algae are studied in an attempt to produce hydrogen cheaply, lasers are used to determine mixed-function oxidase responses, and Zn-uranyl solutions are used to study interaction after crystal growth. The Chemistry Division is experimenting with chemical reactions in coal and coal-related materials. They also use isotopes in different types of soil for leach testing.

A Physics Division lab in Room F-13 was dismantled and refurbished for use by other divisions. Low-level uranium contamination encountered during the cleanup was caused by past operations.

High-Level Radiochemical Laboratory, Building 4501

The High-Level Radiochemical Laboratory is operated by the Chemical Technology Division and used as a multipurpose facility; for example, studies are conducted on fission product release from reactor fuel elements under accident conditions in the four large hot cells.

A decision was made by this division to dispose of excess radioactive material stored in some 31 shielded wall vaults in the building. Because inventory records were missing or incomplete the first task was to characterize the activity and determine radiation levels and extent of contamination present. Radiation readings of up to 5 Gy/h (500 rad/h) were found at contact with spent fuel specimens; alpha contamination from transuranics was greater than 10^5 disintegrations/min in some vaults. Long-term storage had resulted in degradation of packaging with consequent potential for contamination of personnel and facilities. A temporary plastic-lined containment area was constructed outside of those vaults with the higher level of transuranics. Personnel used double suitings of coveralls and respiratory protection, and special handling tools and techniques were devised to minimize exposure. All operations were under the continuous surveillance of area health physicists. Source removal and decontamination of the vaults was performed by members of the Chemical Technology Division during CY 83. The most hazardous operations were conducted during off hours to minimize disruption of routine area activities. Personnel monitoring, including bioassay sampling and whole-body counting, demonstrated that all exposures were less than permissible limits; no contamination was found outside of zoned areas. ALARA principles were followed; there were thought to be no unnecessary exposures and the total man-rem exposure was minimized. This was accomplished by thorough preplanning and excellent cooperation among the divisions involved (P&E, Operations, Chemical Technology, and EOS).

Metals and Ceramics Division, Building 4508

The Metals and Ceramics Division operated various R&D laboratories involved in developing, fabricating, and testing advanced ceramics, high strength alloys, special purpose insulations, and hard coating techniques.

Advanced materials-joining techniques such as laser and electron beam welding are also studied and developed; materials testing may include irradiation and subsequent post-irradiation examination through the use of techniques such as scanning electron microscopy. In addition to surveillance of routine operations in these facilities, health physics personnel participated in the planning of and provided close monitoring for a number of jobs with unusual hazard potential. These included several large work areas (Rooms 254 and 121) being converted from "C-Zone" areas to clean laboratory space. Dismantling of equipment and removal of glove boxes was started in the Ceramics Fuels Alpha Facility (Pu Lab), Room 139.

Health physics consultation in all areas of this work helped promote the ALARA philosophy as well as general laboratory safety.

Transuranium Research Laboratory (TRL), Building 5505

The EOS staff at TRL continued to provide protective and technical support to experimental programs involving the investigation of physical and chemical properties of transuranic elements. Primary emphasis was on ensuring that appropriate containment enclosures were used and that researchers were familiar with the proper safety procedures and techniques.

In addition, the staff assisted in the operation of the TRL ventilation and containment system and served as the Chemistry Division's Radiation Control Officer (RCO) and alternate. The Final Safety Analysis Report and Operations Safety Requirements manual were completed and submitted to DOE for approval.

Accelerator Complex, Buildings 6000, 6010, and 6025

Radiation safety in the accelerator complex during 1983 remained excellent. There were no unusual occurrences or personnel exposures beyond permissible limits and there were no releases that resulted in a spread of contamination beyond zoned areas. Continually operating air monitors in and around the facility indicated effective containment of particulate radioactive materials; no responses significantly above background were observed.

A number of features designed to improve the quality of radiation safety were added and/or initiated during the year: (1) a procedure for testing the Tandem Safety System in use at the Holifield Heavy Ion Research Facility (HHIRF); (2) new shielding mazes installed in the University Isotope Separator-Oak Ridge (UNISOR) area; (3) relocation of the ventilated HEPA filter hood for low-level source work in the UNISOR South Addition area; and (4) the new UNISOR South Addition now in use for research activities.

High Flux Isotope Reactor (HFIR), Building 7900

Neutron radiation damage to the outer (permanent) beryllium reflector ring of the reactor required that it be replaced. This was a major operation requiring the disassembly and reassembly of most of the reactor vessel components including the four engineering facility tubes and the four horizontal beam tubes with their associated shields. In addition major maintenance and replacement operations were performed on other reactor systems, such as the control plate drive and primary heat exchanger systems.

R&SS assistance and surveillance were provided 24 hours per day for six days a week during the three months' shutdown. The potential for high personnel exposures and for the release of contamination was present during most of these operations. There were periods when personnel were required to work directly with highly radioactive and grossly contaminated equipment; however, transferable contamination was confined to the work area itself, except for rare occurrences, and always to the room in which the various operations were performed. Exposure dose equivalents to all personnel involved in the program were kept well below the quarterly limit: the highest accumulated exposure sustained by any of the 45 persons involved in the operation was 6.75 mSv (675 mrem). The average exposure was 3.40 mSv (340 mrem), and the exposure burden for the operation was 0.145 man-Sv (14.5 man-rem).

Transuranium Facility (TRU), Building 7920

Work at the TRU Facility involving separation and purification of heavy elements such as ^{244}Cm , ^{252}Cf , ^{253}Es , and ^{254}Fm continued. Additionally, one ^{236}Ra source was prepared in Cell 9 for an outside purchaser. A few employees received more significant doses than others in the separation and purification processes. Special tools and techniques were developed to help reduce this dose. The ALARA program has been enhanced by the installation of roll-around shields for the process glove boxes. These shields are made of special materials to reduce both the gamma and neutron doses.

Hydrofracture Facility

Continuous surveillance was provided during seven intermediate-level waste (ILW) injections that totaled about 18.8 PBq (509,580 Ci) of activity (predominantly ^{90}Sr and ^{137}Cs). Continuous coverage was also necessary during preparatory maintenance, cell decontamination work, and the well recovery

operation. Although the ^{90}Sr concentrations were extremely high, personnel exposures were kept below maximum permissible levels by careful planning and special monitoring. Ratios of skin dose to penetrating doses varied from 6 to 20, making close surveillance of this work mandatory.

Tank Farm Operation

The Gunitite Tank Sludge Removal Project required frequent monitoring, particularly during maintenance, repair, and transfer of equipment to and from the waste tanks. Contamination control was a major concern with this operation because of its proximity to a frequently used Laboratory thoroughfare. Close surveillance by R&SS staff confined any releases to the zoned area already prescribed for such work and was responsible for minimal penetrating exposures sustained by the Operations Division staff performing the work.

ILW Pipeline, Seal Surface Leaks

Frequent monitoring was provided during the sealing of two ILW pipeline leaks at two separate sites located between Liquid Waste Pit 6 and White Oak Creek. Work involved clearing and excavation, followed by placement of soil, clay, rock, and asphalt covering. Personnel exposures were minimal and contamination was limited to the zoned areas.

Laundry Monitoring Operation

Approximately 500,000 articles of clothing and 207,000 articles such as mops, laundry bags, and towels were monitored at the laundry during 1983. About 5% were found to be contaminated. Of 363,686 khaki garments monitored during the year, only 61 were found contaminated. A total of 11,247 full-face respirators and 1,934 canisters were monitored during the year. Further decontamination was required after the first cleaning cycle for 415 masks and 425 canisters.

Y-12 Activities

Radiation surveillance of ORNL activities in the Y-12 Plant continued to focus on work done by the Fusion Energy, Engineering Technology, and Biology Divisions. Collection and transportation of radioactive waste began to require more attention than in the past as regulations regarding such activities, particularly those pertaining to hazardous materials, became more restrictive.

Operation of experimental equipment such as that related to the EBT, ISX, and other devices developed by Fusion Energy required close attention. During operation of the Medium Energy Test Facility the absence of neutrons at levels requiring limited working times was verified by special monitoring devices. X rays, usually present during the operation of the equipment, were also closely monitored.

6.2 OFF-SITE AND SPECIAL SURVEILLANCE ACTIVITIES

6.2.1 Inspection of Threshold Detector Units

Monthly inspections of the threshold detector units (TDUs) in place at the Laboratory were performed during the year. The TDUs are devices that are located at facilities containing significant quantities of fissile material and are used for determining fission yields from critical reactions. The key

components of these units are foils containing microgram quantities of ^{239}Pu , ^{238}U , and ^{237}Np . Fission fragments from each of these foils, which are detected by visual inspection of track damage in polycarbonate films placed next to them, are used to quantify the neutron fluence at the detector location as well as to qualify its energy spectrum. Figure 6.2 displays one of the units as it is typically installed for passive monitoring. Figure 6.3 shows the interior of one of these units. The inspection consisted of a visual/tactile examination of the locks and seals to ascertain that both were in place.

ORNL-3132-75



Fig. 6.2. Typical installation of threshold detector unit.

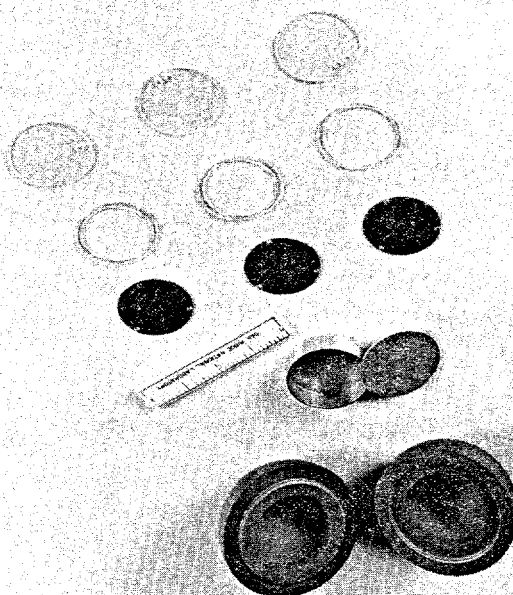


Fig. 6.3. Internals of threshold detector unit.

6.2.2 Preliminary Radiological Characterization Studies of Surplus Facilities

The R&SS Department completed preliminary radiological characterization studies and issued reports on the following facilities during 1983: the shielded transfer tanks (ORNL/CF-83/62), the old ORR water-to-air heat exchangers (ORNL/CF-83/204), and the ORR experimental areas (ORNL/CF-83/250). These reports include discussions of radiation and contamination hazards, isotope inventories, and other safety considerations at each facility. By the end of the year, studies had also been completed and reports were in progress on the Graphite Reactor (ORNL/CF-84/30) and the Low Intensity Testing Reactor (ORNL/CF-84/37).

6.2.3 Work Environment Surveys for Pregnant Employees

The work environment of pregnant employees is surveyed as soon as possible following notification of the pregnancy by the Health Division. The survey consists of measurement by a portable NaI scintillation counter of prevailing penetrating radiation levels in the area. This level is compared with a measurement of background radiation in an office known to be free of radiation or contamination hazards. In work areas where contamination is suspected, surface contamination measurements are made. During the year, 83 such surveys were made, some of which were re-surveys of a work environment, surveys of a changed work environment, or surveys following return to work by an employee. Some female employees returning to work express milk for later infant consumption; such a practice requires that they be assigned to a work environment free of contamination. Even though DOE standards do not prescribe a different limit for pregnant females than for other employees, ORNL

attempts to maintain their exposures to as near background as practicable, and in no case to exceed 500 mrem during the pregnancy.

6.2.4 Response to Off-Site Emergencies

At the request of DOE, R&SS staff responded to two actual off-site emergencies in 1983. The first of these involved a detailed site survey near the crash (on take-off) of a commercial freight airliner carrying packages containing radioactive ^{90}Y and ^{192}Ir that indicated that the shipping containers, although badly burned, had remained intact. The second response involved the search for a missing $^{241}\text{Am-Be}$ source thought to have been lost between Crossville, Tennessee, and Williamsburg, Kentucky. The source was found lying on an open stretch of Interstate 75 near Williamsburg by the ORNL search team 12 hours after it was reported missing.

6.2.5 Oak Ridge Associated Universities (ORAU) Off-Site Assessment Assistance

A member of the R&SS Department provided assistance to the ORAU off-site assessment unit for 14 days in an area survey of a site in Canonsburg, Pennsylvania.

6.2.6 Servicing of Threshold Detector Units

The Lexan disks, which are used to record fission fragment tracks in the threshold detector units at the Reactive Metals, Inc. (RMI) plant in Ashtabula, Ohio, were replaced on site by a member of the R&SS staff. All three disks were removed from each unit and replaced. Four of these units, which are on loan to RMI, are serviced annually.

6.2.7 Consultations

R&SS Department staff provided consultations to the following:

- In February 1983, visited the Wilsonville, Alabama, solvent-refined coal (SRC) SRC pilot plant to advise on the safe handling of tracer radioisotopes used in coal conversion plant studies.
- On November 1, 1983, visited the Pittsburgh Energy Technology Center to advise on radiation safety practices. Recommendations were made concerning safeguards for X-ray generating equipment.

6.2.8 Participation in Emergency Drills

R&SS Department staff participated in the following off-site emergency drills during 1983:

- NUWAX-83 exercise. Six ORNL employees, including four members of the EOS Division, participated in the NUWAX-83 exercise in May 1983 that simulated a helicopter crash involving the release of radioactivity from nuclear weapons. The ORNL team assisted personnel from the State of Virginia in survey and recovery operations similar to those that would occur in a real emergency.
- Sequoyah exercise. A practice drill of the TVA's emergency response capabilities at their Sequoyah Nuclear Power Plant near Chattanooga, Tennessee, was conducted on July 13-14, 1983.

Surry exercise. A practice exercise of the Virginia Power's emergency response capabilities at their Surry Nuclear Power Plant near Newport News, Virginia, was conducted during the period of September 30–October 2, 1983.

6.2.9 DOSAR Facility, Buildings 7709 and 7710

Radiation hazard surveillance and technological assistance were provided for the research efforts at this unique facility, where an unshielded reactor is used in dosimetry development and studies of the biological effects of nuclear radiations. Two international dosimetry intercomparisons were conducted during the year, one related to personnel dosimetry and the other to nuclear accident dosimetry. Two courses of instruction in the techniques of dosimetry in mixed radiation fields were offered during the year, one for personnel dosimetry and one for nuclear accident dosimetry. Participants were from the nuclear power industry, government facilities, and the armed forces.

Several biological studies were continued in which mice, plant seeds, and human cell cultures were irradiated. Also continued were the studies of the effectiveness of various radioprotective drugs injected before irradiation.

Assistance also was provided in the irradiation of badges from radiation accident drills for both ORNL and Y-12, and badges, dosimeters, and/or criticality detectors were irradiated or tested for Y-12, Arizona State University, Bettis Atomic Power, and the Nuclear Research Center, Yavne, Israel.

7. TECHNICAL ACTIVITIES

7.1 PRESENTATIONS AND LECTURES

- W. A. Alexander, "A Statistical Review of TLD Environmental Radiation Measurements of Specific Sites at the ORNL," 28th Annual Meeting of the Health Physics Society, Baltimore, Md., June 19-23, 1983.
- B. D. Barkenbus, "Superfund at Work," IS&AHP Division, ORNL, June 17, 1983.
- B. D. Barkenbus, "Hazardous Waste Management," DEM Basic Training Program, November 30, 1983.
- B. D. Barkenbus, "Handling Hazardous Chemicals," P&E Division (2 sessions), September 22, 1983.
- B. D. Barkenbus, "Review of EPM-16.0 and 10.0," Quarterly EPO meeting, December 19, 1983.
- C. D. Berger, "Calibration of a Large Germanium Array for In-Vivo Detection of the Actinides with a Tissue-Equivalent Torso Phantom," ORNL Workshop on Calibration of Actinide Lung Counters, Oak Ridge, Tenn., May 10, 1983.
- C. D. Berger, "Operational Internal Dosimetry," San Diego Chapter Health Physics Society Annual Meeting, La Jolla, Calif., November 21, 1983.
- C. D. Berger, "Radiation Protection in the Nuclear Industry," Aquinas Jr. College, Nashville, Tenn., December 6, 1983.
- C. D. Berger, taught ten classes at Oak Ridge Associated Universities, REAC/TS, Tennessee Valley Authority-Chattanooga.
- H. M. Braunstein (invited), "Coal Research Related Exposure to PAHs," AIChE National Meeting, November 3, 1983, Washington, D.C.
- H. M. Braunstein, "QA in Sampling," DEM Basic Training Program, June 28, 1983.
- B. A. Campbell, "Wang Word Processing Training Course," EOS Division secretaries, ORNL, March 26, 1983.
- B. A. Campbell, "QA and Your Super Secretaries, We Can't Do It Alone!!" ORNL, Department of Environmental Management, April 29, 1983.
- T. G. Clark, "Health Physics Procedures," presented to Chemical Technology Co-op Students, ORNL, February 3, 1983.
- K. L. Daniels, "Precision and Accuracy," DEM Advanced Training Group, April 8, 1983.
- K. L. Daniels, "Measures of Variability," DEM Advanced Training Group, May 6, 1983.

- K. L. Daniels, M. P. Farrell, J. C. Goyert, R. H. Strand, "Management Information Systems: An Environmental Approach," New Orleans, La., January 19, 1983.
- B. M. Eisenhower, "Hazardous Waste Management Program at ORNL," UCC-ND/GAT Environmental Protection Seminar, December 6-8, 1983.
- B. M. Eisenhower, "Requirements for Disposal of Asbestos Contaminated Material," presented at the 1983 Annual Technical Meeting of the Tennessee Valley Section of the American Industrial Hygiene Association, October 6-7, 1983.
- J. S. Eldridge and T. W. Oakes, "Radionuclide Migration from Shallow Land Burial Sites," presented at 28th Annual Meeting—Health Physics Society, Baltimore, Md., June 19-23, 1983.
- J. S. Eldridge (invited), "Laboratory and Sample Preparation Techniques," 1st Annual DOE/ORO Emergency Preparedness Workshop, Oak Ridge, Tenn., October 13-14.
- J. S. Eldridge (invited), "Toxicology of Radioactive Substances," University of Tennessee, Special Topics in Environmental Toxicology (Dr. Farkas), November 22, 1983.
- M. F. Fair, "Health Physics," lecture presented to members of the Instrumentation and Controls Division, ORNL, February 1983.
- M. F. Fair, "Health Physics," lecture presented to Junior Sciences and Humanities Symposium, March 1983.
- M. F. Fair, "Health Physics," lectures to members of Environmental and Occupational Safety Division, May-June 1983.
- M. F. Fair, "Health Physics," lecture and tour for class from the University of North Carolina at Chapel Hill, May 1983.
- M. F. Fair, "Health Physics," lecture and tour for class from the University of North Carolina at Greensboro, June 1983.
- M. F. Fair, lecture at TRADE Conference, Knoxville, Tenn., October 1983.
- M. F. Fair, coordinated visits for guests from West Germany (January), Taiwan (March), and South Africa (October), 1983.
- B. A. Kelly, "NPDES Parameters I," DEM Basic Training Program, August 25, 1983.
- B. A. Kelly, "NPDES Parameters II," DEM Basic Training Program, October 27, 1983.
- J. T. Kitchings and K. M. Blair, "NERP Environmental Study Center," Environmental Education Association Annual Meeting, Kingston Springs, Tenn., September 23-24, 1983.
- M. W. Knazovich, "Professional Development," DOE and DOE Contractors' Occupational Safety Meeting, New Orleans, La., April 18-22, 1983.
- M. W. Knazovich, "The ORNL Safety Program," ORNL Safety Committee, Chalk River National Laboratory, Chalk River, Ontario, Canada, June 8, 1983.
- C. H. Miller, "Applied Health Physics Assignments and Responsibilities During Laboratory Emergencies," ORNL, September 28, 1983.

- C. H. Miller, "PUMP Technician HP Training," presented to Chemical Technology Division personnel, ORNL, October 28, 1983.
- C. H. Miller, "Protective Clothing," presented as part of the ORAU Applied Health Physics Course, ORAU, November 3, 1983.
- C. H. Miller and W. A. Lindsey, "Health Physics and Safety Orientation for Personnel Designing 3020 Stack Improvements," presented to Lockwood Greene Engineering personnel, ORNL, November 11, 1983.
- C. H. Miller, "Radiation Safety in the Radiochemical Processing Pilot Plant," presented to the Chemical Technology Division, ORNL, July 28, 1983.
- C. H. Miller, "Health Physics Orientation for Building 3019 Construction Personnel," presented to Rust Engineering personnel, ORNL, October 17, 1983.
- C. H. Miller, "Building 3019 Health Physics Orientation," presented to new Plant and Equipment Division personnel assigned to Bldg. 3019, October 11, 1983.
- C. H. Miller, "Protective Clothing," Health Physics and Radiation Protection Course sponsored by NRC, ORAU/MERT, Oak Ridge, Tenn., January 24-March 31, 1983.
- C. H. Miller, "Protective Clothing," ORAU Applied Health Physics Course, ORAU, Oak Ridge, Tenn., June 2, 1983.
- C. H. Miller, "Use of Radiation Monitoring Instruments," presented as part of ORNL's QA&I Departments Radiographers Training/Retraining Program, ORNL, May 26, 1983.
- C. H. Miller, "Health Physics Training for Building 3019 PUMP Technicians," presented as part of the PUMP Technicians Certification Program, ORNL, February 2, 1983.
- C. H. Miller, "Health Physics Training for Building 3019 PUMP Technicians," presented as part of the PUMP Technicians Certification Program, ORNL, March 7, 1983.
- C. H. Miller, "Health Physics Training for Building 3019 PUMP Technicians," presented as part of the PUMP Technicians Certification Program, ORNL, July 7, 1983.
- C. H. Miller, "Health Physics Training for Building 3019 PUMP Technicians," presented as part of the PUMP Technicians Certification Program, ORNL, October 28, 1983.
- T. W. Oakes, "Quality Assurance," DEM Advanced Training Program, March 18, 1983.
- T. W. Oakes, "Operations with Significant Figures," DEM Advanced Training Program, March 25, 1983.
- T. W. Oakes, "Averages and Means," DEM Advanced Training Program, April 15, 1983.
- T. W. Oakes, "Environmental Monitoring at ORNL," Board of Radioactive Waste Management, National Research Council, NAS, October 3, 1983.
- T. W. Oakes, "Control of Chemical Purchases and Their Receipt and Transfer," National Safety Council, Orlando, Florida, January 21, 1983.
- T. W. Oakes, "Hazardous Chemical Control," Winter ASTM Meeting, Orlando, Florida, January 20, 1983.

- T. W. Oakes, "Impact of EPA Changes in NESHAP on DOE/ORO Plants," EPA and DOE NESHAP Meeting, January 18, 1983.
- T. W. Oakes, "The Use of Autoradiographic Techniques in the Environmental Surveillance Program at ORNL," HPS Advanced Meeting, January 20, 1983.
- T. W. Oakes, "Control of Hazardous Materials—Issues," 58th Annual Western Pennsylvania Safety/Health Conference, April 5, 1983.
- W. F. Ohnesorge and T. W. Oakes, "Radioactive Release Limits—Clean Air Act," Joint Meeting of North Carolina Chapter and East Tennessee Chapter of the Health Physics Society, October 21, 1983.
- D. C. Parzyck, Union Carbide Corporation Engineering Staff, addressing environment, health and safety concerns, December 5, 1983.
- D. C. Parzyck, Training for ORNL supervisors, ORNL Environment, Health Physics, and Safety Program, October 27, 1983.
- D. C. Parzyck, Training for ORNL supervisors, ORNL Environment, Health Physics, and Safety Program, July 28, 1983.
- D. C. Parzyck, ORNL Workshop on Calibration of Actinide Lung Counters, Opening Remarks and a History of the Whole-Body Counting Facility, May 10, 1983.
- D. C. Parzyck, Training for ORNL Supervisors, ORNL Environment, Health Physics, and Safety Program, April 19, 1983.
- J. C. Richter, "Safety Procedures at TRU," presented to Chemical Technology, Plant & Equipment, Analytical Chemistry, and Instrumentation and Controls divisions personnel, ORNL, October 11, 1983.
- D. R. Simpson, "Design of Safety Interlocks," Health Physics and Radiation Protection Course sponsored by NRC, ORAU/MERT, Oak Ridge, Tenn., March 10, 1983.
- D. R. Simpson, "Accelerator Health Physics," Health Physics and Radiation Protection Course sponsored by NRC, ORAU/MERT, Oak Ridge, Tenn., March 11, 1983.
- D. R. Simpson, "Decontamination & Decommissioning of Nuclear Facilities," Health Physics and Radiation Protection Course sponsored by NRC, ORAU/MERT, Oak Ridge, Tenn., March 24, 1983.
- D. R. Simpson, "Upgrading the ORNL Off-Gas and Cell Ventilation System: Applications for Future D&D Work," presented at the Health Physics Society's 28th Annual Meeting, Baltimore, Md., June 19–24, 1983.
- D. R. Simpson, "Introduction to Radiation," Knoxville/Knox County Teachers' Center, Knoxville, Tenn., October 13, 1983.
- D. R. Simpson, "Decontamination & Decommissioning of Nuclear Facilities," Health Physics and Radiation Protection Training Course sponsored by NRC, ORAU/MERT, Oak Ridge, Tenn., November 1, 1983.

- P. Stegnar, J. S. Eldridge, N. A. Teasley, and T. W. Oakes, "Environmental Application of a Germanium Well Detector," presented at "Gatlinburg Conference" (Knoxville), October 1983.

7.2 PUBLICATIONS

- W. A. Alexander, "The Use of DOE/RECON in Environmental Protection," in *Proc. 1982 UCC-ND/GAT Environmental Protection Seminar*, CONF-820418, Gatlinburg, Tenn., April 5-7, 1982 (1983).
- W. A. Alexander, K. L. Daniels, D. W. Parsons, and J. B. Watson, "A Statistical Review of TLD Environmental Radiation Measurements of Specific Sites at the Oak Ridge National Laboratory," *Health Phys.* **45**(1): July 1983.
- J. D. Allen, B. A. Kelly, C. K. Johnson, and T. W. Oakes, "The Spills Problem and Applied Artificial Intelligence," in *Proc. 1982 UCC-ND/GAT Environmental Protection Seminar*, CONF-820418, Gatlinburg, Tenn., April 5-7, 1982 (1983).
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- C. D. Berger, "An α - β - γ Spectrometer for Direct Decontamination of Soils," *Health Phys.* **44**(6):684-88 (1983).
- C. D. Berger and B. H. Lane, *Chest Wall Thickness and Percent Thoracic Fat Estimation by B-Mode Ultrasound: System and Procedure Review*, ORNL/TM-8578, Oak Ridge Natl. Lab. (1983).
- C. D. Berger and B. H. Lane, "Calibration of a Large Hyperpure Germanium Array for In-Vivo Detection of the Actinides with a Tissue-Equivalent Torso Phantom," in *Proc. ORNL Workshop on Calibration of Actinide Lung Counters*, May 10-13, 1983, Oak Ridge, Tenn. (1983).
- C. D. Berger, B. H. Lane, and T. Hamrich, "Clearance of ^{201}Tl Contaminate Following Intravenous Injection of ^{201}Tl ," *Health Phys.* **45**(5):999-1001 (1983).
- H. M. Braunstein, D. J. Pack, and T. W. Oakes, "Intercomparison of Stable Element Content of Foods by Statistical Methods," in *Trace Substances in Environmental Health-XVI*, D. D. Hemphill, ed., University of Missouri, Columbia, Mo. (1983).
- H. M. Braunstein, B. M. Eisenhower, and W. G. Dreibelbis, "PAH-Contaminated Materials Management at Oak Ridge National Laboratory," in *Polynuclear Aromatic Hydrocarbons: Formation, Metabolism, and Measurement*, W. M. Cooke and A. J. Dennis, eds., Battelle Press, Columbus, Ohio (1983).
- M. V. Buchanan, G. L. Kao, B. D. Barkenbus, C.-h. Ho, and M. R. Guerin, "Chemical Characterization of the Mutagenic Neutral Aromatic Polar Fractions of Petroleum Substitutes," *Fuel* **62**:1177-1180 (1983).

- W. A. Burkhardt, J. R. Voshell, Jr., J. S. Eldridge, and T. W. Oakes, "Dispersal of Radionuclides from a Contaminated Pond by Emerging Aquatic Insects," *Health Phys.* **45**:222 (1983).
- K. L. Daniels, M. P. Farrell, J. C. Goyert, and R. H. Strand, "Management Information Systems: An Environmetrics Approach," in *Proc. Eighth Annual SAS Users Group Int. Conf.*, New Orleans, La., pp.332-335 (1983).
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- B. M. Eisenhower and T. W. Oakes, "Hazardous Materials Management and Control Program at Oak Ridge National Laboratory—Environmental Protection," in *Proc. 1982 UCC-ND/GAT Environmental Protection Seminar*, CONF-820418, Gatlinburg, Tenn., April 5-7, 1982 (1983).
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7.3 EOS LUNCHEON SEMINARS

- "A Tour of Russia," G. R. Patterson, March 1, 1983.
- "Mercury in the Environment," Peter Stegnar, April 12, 1983.
- "ORNL Participation at NUWAX-83," D. R. Simpson, May 18, 1983.

7.4 PROFESSIONAL ACTIVITIES AND ASSOCIATIONS

- J. F. Alexander, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- W. A. Alexander, member, Health Physics Society; member, area representative, WATtec; fall picnic, public information, publicity committees, East Tennessee Chapter Health Physics Society; chairman, Audiovisual and Communications Committee, Health Physics Society's Nineteenth Midyear Topical Symposium, 1986; member, East Tennessee Chapter American Nuclear Society.

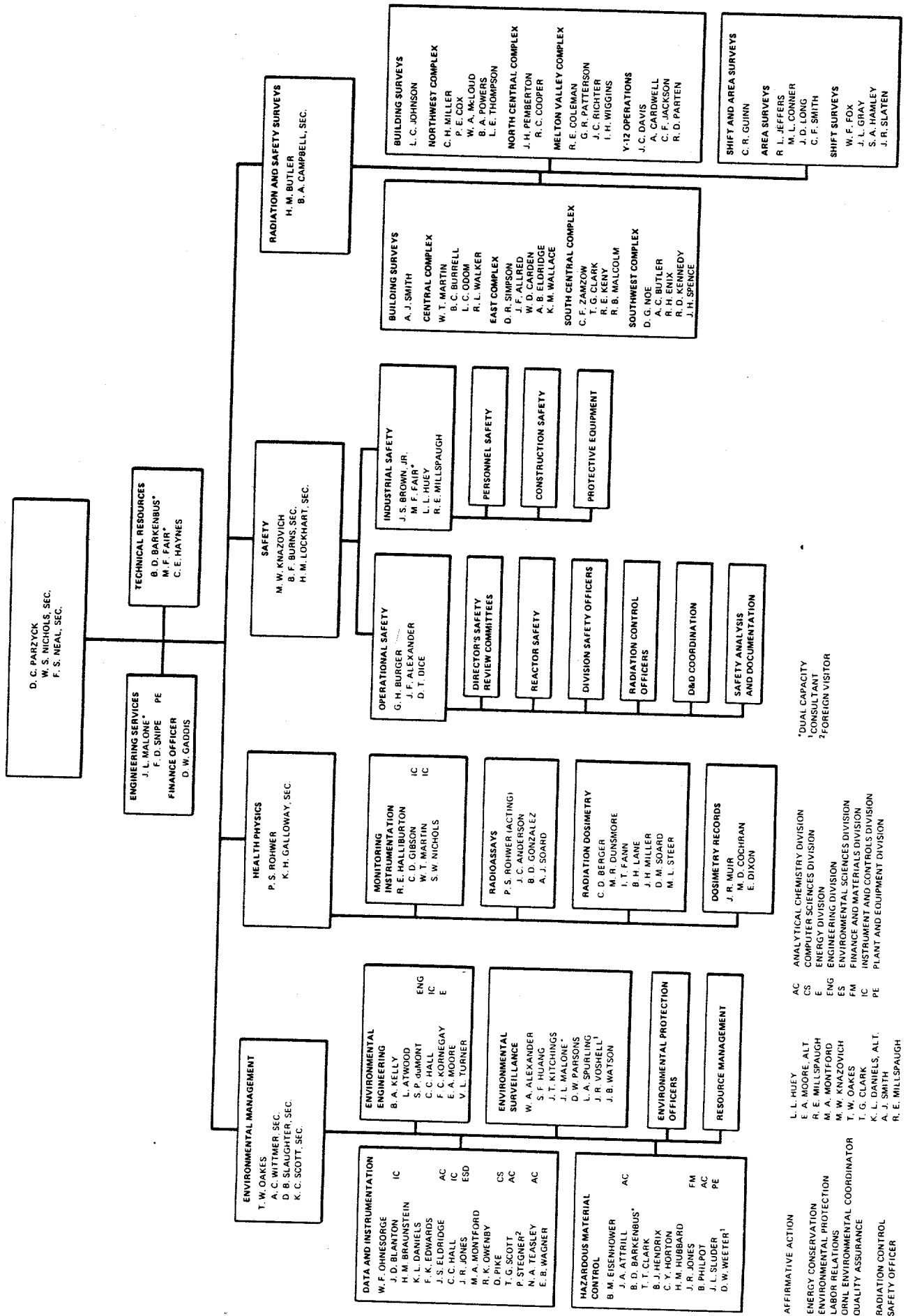
- L. L. Atwood, member, American Institute of Chemical Engineers; member, Society of Women Engineers.
- B. D. Barkenbus, member, American Chemical Society; member, East Tennessee Chapter Health Physics Society; member, East Tennessee Chapter Association for Women in Science.
- C. D. Berger, certified by American Board of Health Physics (1983); member, East Tennessee Chapter Health Physics Society; chairperson, Vendors' Meeting Committee; charter member, San Diego Chapter Health Physics Society; member, Health Physics Society; affiliates committee member, Health Physics Society; member, Sigma Xi.
- J. T. Blackmon, Jr., member, American Alliance for Health & Safety; member, American Public Health Association; member, American School and Community Safety Association; member, National Fire Protection Association; member, National Safety Management Society; member, Society of Fire Protection Engineers (national and local).
- H. M. Braunstein, member, American Chemical Society; member, American Public Health Association; member, Society for Risk Analysis; member, Tennessee Valley Section, Industrial Hygiene Association; member, East Tennessee Chapter Health Physics Society; member, Sigma Xi.
- J. S. Brown, member, East Tennessee Chapter American Society of Safety Engineers.
- G. H. Burger, member, East Tennessee Chapter Health Physics Society; member, American Nuclear Society; senior member, Instrument Society of America.
- A. C. Butler, member, Board of Directors, National Radiation Registry Protection Technologists; member, East Tennessee Chapter Health Physics Society.
- H. M. Butler, chairman, Admissions Committee, Health Physics Society; member, Chattanooga State Advisory Committee for Nuclear Technology; member, East Tennessee Chapter Health Physics Society.
- W. D. Carden, member, East Tennessee Chapter Health Physics Society.
- T. G. Clark, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; certified by Board of American Health Physics.
- T. T. Clark, member, American Society of Clinical Pathologists.
- R. E. Coleman, member, East Tennessee Chapter Health Physics Society.
- M. L. Conner, member, East Tennessee Chapter Health Physics Society.
- K. L. Daniels, member, American Statistical Association; member, Beta Beta Beta; member, Phi Kappa Phi.
- J. C. Davis, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- D. T. Dice, member, ANS Committee 15.14, Physical Security of Research Reactors; member, East Tennessee Chapter Health Physics Society.
- E. Dixon, member, East Tennessee Chapter Health Physics Society.
- B. M. Eisenhower, member, American Industrial Hygiene Association; member, American Society of Safety Engineers; member, American Society for Testing & Materials and ASTM Committee

- D-34; member, East Tennessee Chapter American Society of Safety Engineers; member, East Tennessee Chapter Health Physics Society.
- J. S. Eldridge, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, Executive Board of Environmental Radiation Section Health Physics Society; member, Subcommittee No. 8, Radiological Measurements of the Intersociety Committee on Methods of Air Sampling and Analysis, Health Physics Society; subcommittee member, National Committee for Clinical Laboratory Standards.
- M. F. Fair, member, Executive Council, East Tennessee Chapter Health Physics Society.
- I. T. Fann, member, East Tennessee Chapter Health Physics Society.
- B. D. Gonzalez, member, East Tennessee Chapter Health Physics Society.
- J. L. Gray, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- C. R. Guinn, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, Southeastern Section American Physical Society.
- R. E. Halliburton, certified by American Board of Health Physics; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- S. A. Hamley, member, East Tennessee Chapter Health Physics Society.
- S. F. Huang, member, East Tennessee Chapter Health Physics Society; member, Society of Risk Analysis; member, Health Physics Society.
- L. L. Huey, member, East Tennessee Chapter American Society of Safety Engineers.
- H. M. Hubbard, member, East Tennessee Chapter Health Physics Society; member, American Society of Safety Engineers.
- C. F. Jackson, member, American Society of Safety Engineers.
- R. L. Jeffers, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- B. A. Kelly, member, Chi Epsilon; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- M. W. Knazovich, member, East Tennessee Chapter American Society of Safety Engineers.
- B. H. Lane, member, East Tennessee Chapter Health Physics Society; chairperson, Membership Committee.
- J. D. Long, member, East Tennessee Chapter Health Physics Society.
- C. H. Miller, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- J. D. Miller, member, East Tennessee Chapter American Society of Safety Engineers.
- R. E. Millsbaugh, member, East Tennessee Chapter Health Physics Society.
- J. L. Malone, member, East Tennessee Chapter Health Physics Society.

- M. A. Montford, member, East Tennessee Chapter Health Physics Society; member, International Toastmistress Conference.
- E. A. Moore, member, East Tennessee Chapter Health Physics Society.
- J. R. Muir, member, Health Physics Society; President-elect, East Tennessee Chapter Health Physics Society; member, Association of Records Managers and Administrators.
- T. W. Oakes, member, American Society for Testing and Materials; member, Industrial Hygiene Association; member, American Nuclear Society; member, Health Physics Society; member, Ad Hoc Committee—"Formation of Environmental Section," session chairperson, Operational Health Physics Session, Annual Meeting; technical reviewer for Health Physics Journal; member, East Tennessee Chapter Health Physics Society; member, Program Committee; chairperson, Midyear and Annual Meeting Committee; member, American Association for Advancement of Science; member, The New York Academy of Sciences; member, American Society of Professional Ecologists; member, American Society of Safety Engineers.
- W. F. Ohnesorge, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- R. K. Owenby, member, East Tennessee Chapter Health Physics Society.
- D. W. Parsons, member, East Tennessee Chapter Health Physics Society.
- G. R. Patterson, charter member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; certified by American Board of Health Physics.
- B. A. Powers, member, NRRPT; member, East Tennessee Chapter Health Physics Society.
- P. S. Rohwer, certified by American Board of Health Physics; member, Health Physics Society; member, Program Committee, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, Executive Committee, 1986 Midyear Topical Symposium; chairman, Special Arrangements Committee, 1986 Midyear Topical Symposium; member, Review Committee, ORAU; member, Sigma Xi.
- D. R. Simpson, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; chairman, Technical Committee, 1986 Health Physics Society Midyear Symposium.
- J. R. Slaten, member, East Tennessee Chapter Health Physics Society.
- D. B. Slaughter, member, East Tennessee Chapter Health Physics Society.
- J. D. Story, member, Wildlife Society.
- L. E. Thompson, member, East Tennessee Chapter Health Physics Society.
- V. L. Turner, member, East Tennessee Chapter Health Physics Society.
- E. B. Wagner, member, American Radio Relay League; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- K. M. Wallace, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.
- A. C. Wittmer, member, East Tennessee Chapter Health Physics Society; Professional Secretaries International—Oak Ridge Chapter Recording Secretary.

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